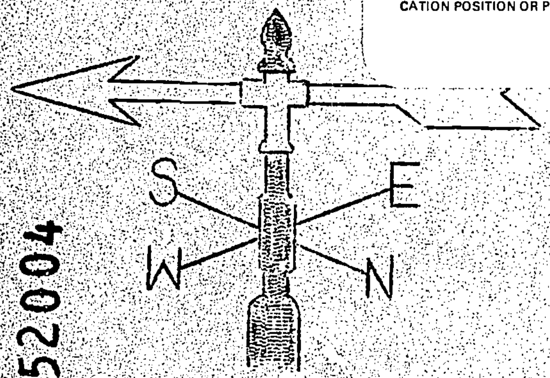
DOCUMENT RESUME

ED 052 004 SE 010 157

| | |
|---|---|
| TITLE | DISCUS Ninth Grade, Earth Science. |
| INSTITUTION | Duval County School Board, Jacksonville, Fla. Project DISCUS. |
| PUB DATE | Sep 69 |
| NOTE | 149p. |
| AVAILABLE FROM | DISCUS, 1011 Gilmore Street, Jacksonville, Florida 32204 |
| EDRS PRICE | EDRS Price MF-$0.65 HC Not Available from EDRS. |
| DESCRIPTORS | *Disadvantaged Youth, *Earth Science, *Instructional Materials, Laboratory Procedures, Science Activities, *Secondary School Science, *Teaching Guides |

ABSTRACT

Included are instructional materials designed for use with disadvantaged students who have a limited reading ability and poor command of English. The guide is the first volume of a two volume, one year program in earth science, and contains these four units and activities: Earth Materials, 8 activities; Weather, 10 activities; Water, 4 activities; and Water Cycle, 6 activities. A formal textbook is not used in this program, and the learning process relies on class discussion supported by audiovisual materials and small group laboratory activities. Each lesson has a suggested format for teachers to follow in directing activities, with suggested teacher comments. Following each teacher section is the printed material for student use, which generally includes a list of required equipment for small group activities, introduction and procedures, and fill-in questions relating to the completed activity. The volume begins with extensive "guidelines for creating an appropriate classroom environment." (PR)

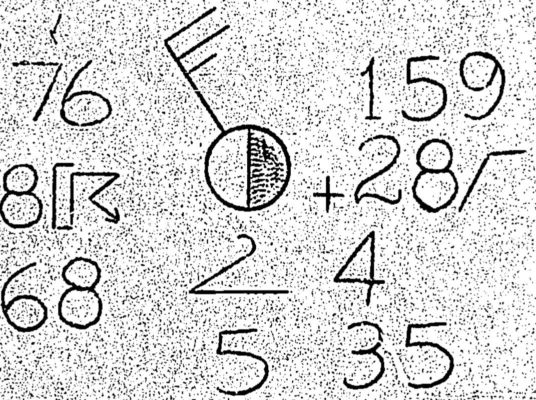


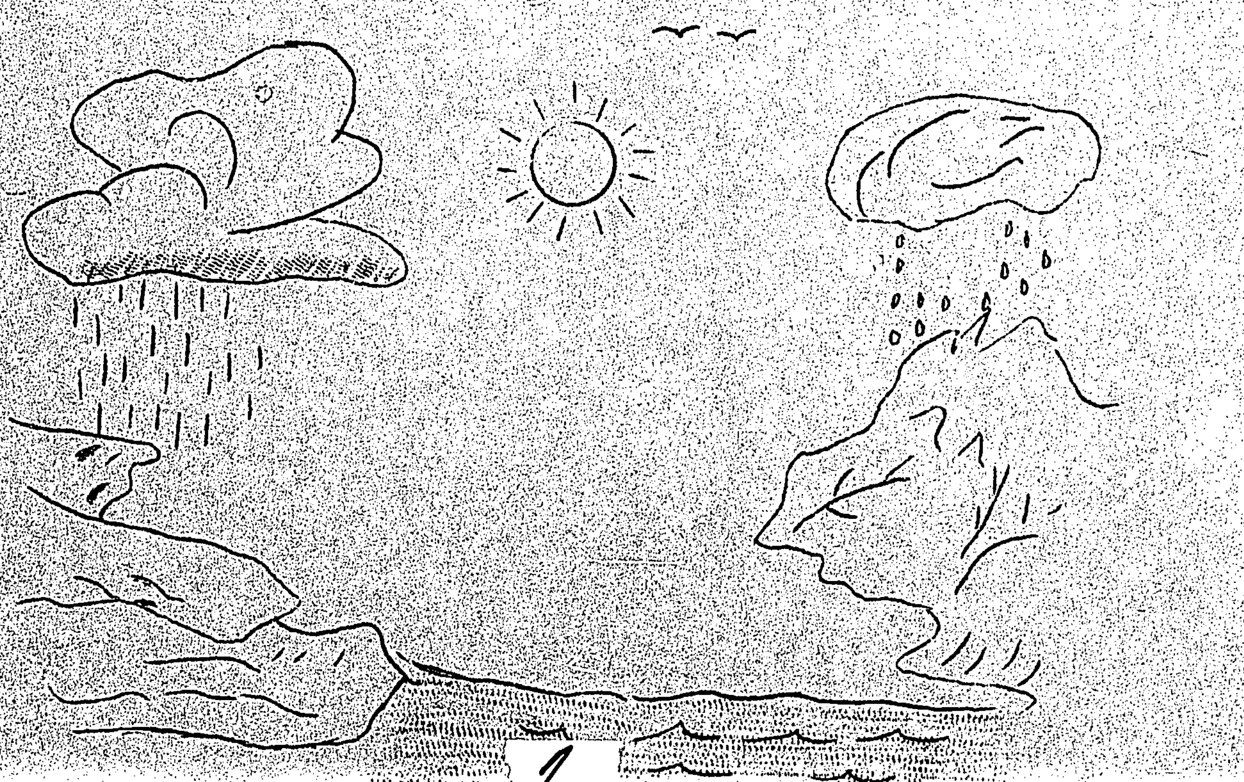

# DISCUS

# NINTH GRADE

# EARTH

# SCIENCE



# DISCUS

1011 Gilmore Street
Jacksonville, Florida 32204



THE MATERIAL CONTAINED IN THIS MANUAL IS EXPERIMENTAL AND NOT IN FINISHED FORM.

IT HAS BEEN PREPARED FOR USE BY THE DISCUS PROJECT AND ANY OTHER USE REQUIRES THE WRITTEN CONSENT OF THE PROJECT DIRECTOR.

The DISCUS project has developed a course of study in science for the junior high grades (7-9). The material for each grade level has been bound into two manuals.

| | |
|---|---|
| GRADE 7 | BIOLOGICAL SCIENCE |
| GRADE 8 | PHYSICAL SCIENCE |
| GRADE 9 | EARTH SCIENCE |

Your comments concerning these materials will be appreciated. For further information, contact the project director.

Revised
9-1-69

DISCUS NINTH GRADE EARTH

TABLE OF CONTENTS



* Reading Activities

I

# GUIDELINES FOR CREATING AN APPROPRIATE CLASSROOM ENVIRONMENT FOR EDUCATIONALLY DISADVANTAGED YOUTH APPLIED IN AND SUPPORTED BY THE PROJECT

1. Assumptions Made Regarding Educationally Disadvantaged Youth

    a. Human ability is to a large extent a social product. It depends upon the opportunities in the environment for meaningful and varied experiences. In many areas it does not develop unless recognized and encouraged by society.

    b. Educationally deprived children have had a narrow range of experiences in a limited environment, hence have a lack of confidence in themselves in a classroom situation.

    c. The conceptual development and the cultural heritage of educationally deprived children is inferior to that of children in more favorable environments.

    d. Because of limited experiences, educationally deprived children are limited in their ability to communicate with others orally or by means of reading and writing.

    e. The child who grows up in a culture of poverty has a strong feeling of fatalism, helplessness, dependence, and inferiority in social situations.

    f. By the time educationally deprived children enter school they have absorbed the basic attitudes and values of their subculture of poverty. As a result they are not ready to take advantage of the educational opportunities in the school or of opportunities that may come as a result of changed conditions during their lifetime.

    g. Any significant change in the relative position of the educationally deprived child requires a preferential treatment that will compensate for his inadequacies. These children require modified teaching techniques and a specially constructed curriculum if they are to succeed in school. They need special materials and devices to fill the gaps in

their experience.

h. The time of readiness to learn can be advanced and the quality of development can be enriched by working with educationally deprived children before they show overt signs of readiness.

i. Deprivation is largely due to failure of environmental agents:

   a. failure to provide children with necessary nourishment before they are ready to exercise specific capacities.

   b. failure to use and develop these capacities once they are ready for exercise.

j. Although the preschool years are characterized by the most rapid change and growth and so are the most important years, yet the adolescent years are also a period of rapid change and growth, hence, these years are fruitful ones for the re-orientation and development of educationally deprived children.

k. Wherever poverty exists throughout the world there is a remarkable similarity in the style of life which may be called a "culture of poverty". This culture provides the human beings living in it with a design for living that permits their survival. This similarity is found in the structure of families, in interpersonal relations, in value systems, in spending habits, and in their tendency to live in the present with little thought of the future. The high incidence of common law marriages and of households headed by women are characteristic of this culture wherever it occurs.

2. Guidelines Used to Determine Science Experiences for Educationally Disadvantaged Youth

   a. Classroom studies should be related to the students' contemporary experiences in their society. Certain aspects of historical development may be helpful, but a consideration of these for endorsement and clar-

ification will come after the ideas are crystallized through concrete experiences.

b. A definite classroom situation must be provided in which new experiences with objects and events are related to past experiences in such a manner that new relationships are discovered. By associating several new experiences during a short period of time, an awareness of the basic principles that account for these experiences may be developed.

c. Science experiences must be developed from the common interests of the learners and result in an understanding of the basic principles of science that are related to these interests.

d. Initial learning of first level abstractions comes from observations of particular objects and events via all of the senses. First hand experiences should be emphasized.

e. There is a continuum in learning experiences that ranges from observation of particular objects and events, through those presented using multi-sensory aids, through the presentation of abstract concepts. Within the continuum of experiences, those located toward the concrete end are preferable.

f. Motivation for further learning will result from meaningful and enjoyable experiences with objects and events. Whenever possible "discovery" experiences should be planned for through "pre-eureka" procedures. Successful experiences in accounting for particular objects and events will provide motivation for additional experiences with other objects and events.

g. Audio-visual materials should be developed for use in initiating activities; for use in lieu of concrete experiences where these are impractical; and for use in providing additional enriching experiences.

h. The lack of communication skills and the lack of self-confidence make

mandatory that educationally deprived children succeed in what they do. The tasks they undertake in school must be measured in difficulty and be ordered sequentially to guarantee success.

i. A wide range of materials together with opportunities to use these materials in meaningful ways must be provided if each educationally deprived child is to enhance his own self-confidence by noting his own growth in ideas and skills.

j. The major outcome of classroom experiences in science is to create in the educationally disadvantaged youth a desire to learn and a positive attitude toward school.

k. The school program should improve the basic skills of speaking and reading.

l. Culturally disadvantaged adolescents should be permitted to specialize in an area in which they are specially interested.

3. Guidelines Used to Determine How to Teach Science to Educationally Disadvantaged Youth.

   a. The teacher must accurately assess the strengths, weaknesses, and interests of each child in order to counsel and guide each in his pursuit of knowledge.

   b. Instruction will of necessity be largely with small groups rather than with the total class.

   c. The teacher must know the content and the processes of science; the childrens' environment, their fears and concerns, and be skillful in guiding their learning experiences.

   d. Educationally deprived adolescents will have had many frustrating experiences so special care must be taken to enable each to succeed in each task undertaken. This success should be used to reinforce and to motivate further learning.

e. The teacher must be willing for the child to deal primarily with specific objects, events, or persons as these objects, events or persons relate to himself, rather than to be concerned primarily with generalized activities.

f. The teacher as a discussion leader accepts every response as a contribution and by questions, suggestions, and vocabulary directs the development of the concept.

g. The teacher must be able to arrange a learning situation in which the youth's belief in himself, his self-image, escalates. Each must operate responsibly in a self-directed way to build a confident self-image.

h. The teacher should become an active partner with the pupils while maintaining an appropriate teacher image fostering abilities before, as well as during, the expected maturation time for these abilities.

i. Even though educationally deprived, each child will have had many experiences that may be used to promote learning.

j. The same concepts should be developed in several ways from a number of different but related experiences.

k. The major purpose of laboratory experiences is to promote creative thinking, not to manipulate equipment.

l. Reading materials should be selected to supplement the classroom actiities out of which basic principles have been developed. In this way the basic principles may be firmly fixed in mind and also skills and habits of reading may be taught.

m. Assignments should be short. Emphasis should be on quality of work rather than on quantity of work.

n. Vocabulary load should be kept at a minimum level. Special effort should be made to teach the required vocabulary.

o. Mathematical calculations should be kept at a minimum level so that measurements and quantitative treatment of results enhances rather than stifles learning.

p. Testing should be used primarily to promote learning. It should be situation centered and involve such skills as interpretations of data, application of principles, the formulation of appropriate hypotheses, as well as to enable the student to assess his comprehension.

4. Guidelines Used to Select Science Experiences For Educationally Disadvantaged Youth

   a. Selection of topics for individual, small group or class investigation must provide avenues that insure success. Therefore, the investigation must center around directed inquiry rather than unassisted discovery.

   b. Each illustrative and investigative activity should:

      a. relate to the pupils' common experiences

      b. lead to a better understanding of the pupils' invironment

      c. stem from and enhance the pupils' interest

      b. be specific rather than generalized, especially at the beginning.

      e. furnish a basic for improving language skills, especially reading and oral expression

      f. be of measured difficulty so that each may succeed.

   c. Each piece of apparatus should be:

      a. simple so that attention may be focused on significant observations

      b. so designed as to clearly show-perhaps to magnify-the quality being observed.

      c. safe to use

      d. easy to manipulate

      e. relatively durable

      f. relatively inexpensive

      g. easy to store

# INTRODUCTION

The teaching procedures offered in this program are experimental. The teacher i
teacher is offered the flexibility required to meet the needs of the different pupils while directing their learning activities in a meaningful sequential manner. The major emphases are placed on concrete experiences and the quality of experiences rather than on the quantity of content.

The material is written with the assumption that the students have a limited reading ability and a poor command of the English language. The formal textbook has been eliminated placing the responsibility of instruction entirely in the hands of the teacher. He must direct the learning processes by means of student-teacher verbal interactions with emphasis being placed on oral discussions, reinforcements, and the development of a sound scientific approach. One of the basic problems -- that of communication --- can be greatly alleviated by initially utilizing the students' colloquialisms. Extensive use of audio-visual materials is necessary to provide meaningful concrete experiences.

The teaching will normally progress through three phases:

1. Initial discussion supported by audio-visual materials to stimulate interest.

2. Small group laboratory activities supported by discussions of particular relevant information.

3. Final discussion to establish a conceptual framework and lead into the next topic.

A suggested format for the teacher to follow in direction the class is presented in detail. Suggested comments to be made by the teacher to the class are written in CAPITAL LETTERS; suggested procedures and anticipated responses are written in small type. Printed materials to be used by the students are designated by the letter "E" followed by a sequential number (E-2). These are to be issued to the student at the

teacher's discretion. This manual is only a guide for the teacher in preparing for class. It is not a student manual.

This manual is separated into units. Each unit contains several topics (statements of concept) which are demonstrated by several student activities. This may be graphically represented as:

Earth Science Manual

Unit 1 | Unit 2 | Unit 3 | Unit 4 | Unit 5

Unit 1

Topic 1: E-1 E-2 E-3

Topic 2: E-4 E-5 E-6 E-7

Topic 3: E-8 E-9 E-10

Topic 4: E-11 E-12 E-13 E-14

The TEACHER RESOURCE section is provided for the convenience of the teacher as a quick reference for related factual material. This is not necessarily the material to be presented to the class. The TEACHER DIRECTION section provides the materials and procedures to be used in the classroom.

The student written materials are being provided for the experimental classes. A copy of each activity has been inserted following the teacher directions in the teacher's manual. They are arranged in the order that they would normally be distributed by the teacher. Additional copies may be made by the various means of duplication.

Transparencies have been prepared for the experimental classes and are labeled the same as the activities they are to supplement. Printed copies of these transparencies may be produced by various thermo processes.

This program is being developed upon principles, procedures, and techniques found to be effective in working with all children. The guidelines and assumptions basic to DISCUS are also basic to sound teaching practices and classroom behaviors in any part of the country.

The DISCUS program is written specifically for a select group of students in Jacksonville, Florida and therefore reflects the immediate community, appropriate reading level and a projected comprehension rate. Modifications to the program in these areas should make the DISCUS program appropriate for any group of students.in any part of the country.

Topic 1 - The initiation of the discussion pattern is to establish rapport between the teacher and students.

The purpose of the introductory discussion is twofold; to establish a discussion pattern that reflects critical thinking and questioning, and to establish an initial rapport between the teacher and the students in the classroom. The topic consists of twenty-three separate optical illusions on transparencies to be placed on the overhead projector.[1] The students are to be encouraged to discuss the illusions freely and informally. It can be assumed that the students will be reluctant to participate for many reasons, some of which may be: (1) due to past experiences with failure, (2) peer group influences, (3) fear of giving wrong answers resulting in ridicule, and (4) being conditioned not to participate. The teacher must establish an atmosphere conducive to free discussion and questioning. Each student reply should be accepted, modified as necessary, and reinforced as a contribution. By design, optical illusions will serve this purpose quite well for there is not one entirely correct answer that can be determined without intensive questioning. Use as many of the illusions as needed to establish the initial rapport.

The optical illusions should stimulate interest and improve communication in all three phases of teaching. This introductory activity is designed to "break the ice" and for orientation. The teacher should talk as little as possible but should not be reluctant to capitalize on points and suggestions that lead to the development of the pre-determined goals--that is to establish rapport and critical thinking.

1. These may be purchased from the 3-M Company. Approximate cost is $35.00

Most of what the teacher says is said in question form rather than expository form. His responses to student statements are largely questions or suggestions. An example would be if a student questions whether or not a line is straight, suggest the use of a straight-edge to determine the answer. The results of the discussion should develop the idea that only through questions and investigations can answers and solutions be determined.

TEACHER DIRECTION

Place a transparency of an optical illusion on the overhead projector, WHAT DOES THAT THING LOOK LIKE? Encourage extensive discussion. Answer questions with question such as "What do you think it is?" or solicit voluntary answers from the class. Capitalize on and encourage students' suggestions for determining answers in a scientific manner such as observing, measuring, inferring, and experimenting.

Follow the same procedures for other transparencies.

In conclusion, point out that the same object may appear different to different individuals. This is a problem of science. Interject the idea that individuals are different in thought as well as appearance. Examples are how fat is "fat", how tall is "tall", where is "there".

# UNIT I

## EARTH MATERIALS

This unit is to introduce the students to the new method of instruction and the relationships of water, land, and atmosphere. The activities are very simple but require a lot of student activity. This unit contains eight activities that should show that the earth can be classified into three basic categories - hydrosphere, lithosphere, and atmosphere. Although these are three distinguishable categories, there is a definite relationship whereby one category is directly effected by the others. The atmosphere is not pure air and it contains water and solid materials. The lithosphere, although solid, contains air and water; likewise the hydrosphere contains solid and gases.

The activities of this unit are:

| | |
|---|---|
| E-1 | HYDROSPHERE, LITHOSPHERE AND ATMOSPHERE<br>(Use filter paper to see the dirt in the air and pond water) |
| E-2 | AIR IN THE LAND AND WATER<br>(Use of heat and a porous rock will show bubbles of air in water) |
| E-3 | TEMPERATURE<br>(Familiarization of the use of thermometers) |
| E-4 | HOW CURRENTS CARRY HEAT ENERGY IN WATER AND IN AIR<br>(Different temperatures of water will set up currents that can be seen by using a dye) |
| E-5 | EFFECTS OF TEMPERATURE ON SOLIDS IN THE HYDROSPHERE<br>(The extreme coldness of dry ice will cause quick settling of dirt from muddy water) |
| E-6 | CENTRIFUGAL FORCE<br>(Whirling action cause deposition) |
| E-7 | PRECIPITATION DUE TO CHEMICAL ACTION<br>(Alum causes fast deposition due to chemical action) |
| E-8 | AN IMAGINARY STORY OF THE TRAVELS OF A DROP OF WATER<br>(Narrative description to summarize the unit) |

## Unit 1 EARTH MATERIALS

TEACHER RESOURCE

The Earth Sciences are dependent upon the more basic sciences: mathematics, physics, chemistry and biology. The integration of these disciplines requires investigations pertaining to basic principles of the broad field of science. To many students Earth phenomena or principles may seem strange or inconceivable. The student living in the deprived sections of cities is constantly in an environment which is usually divorced from an appreciation of the Earth and Space Sciences. The skies are not generally clear due to lights and atmospheric conditions. Soils are considered dirt which is found on floors, food or themselves and thus undesirable. Rocks are things hauled on dump trucks, or used in the building industry, not a part of a desirable place to play or hike. Botanical representatives are found in recreation areas subject to man's whims. Zoological representatives are generally undernourished dogs, cats or an occasional horse in a parade. To the student the Earth is not a magnificent masterpiece worthy of investigation. It is rather a limited geographic area that contains peer groups, meaningless granules of soil that are enemies (dirt), and man-manipulated materials in defense of the undesirable elements of nature.

The physical sciences and biological sciences serve as a basis for the Earth Sciences. The Earth Sciences have little meaning among the crowded buildings. concrete sidewalks, asphalt streets and neon lights. In their study of the Earth Sciences, students can move beyond the concrete sidewalks and asphalt pavements to wholesome experience in the great outdoors—a direction for social improvement. The instructor must relate the activities to everyday occurences as well as to the basic principles of the discipline. The students will relate to the material if given the opportunity in class discussion. This in turn must be used to develop a mental model from believable, real experiences.

Topic 1 - Solids, liquids and gases are present in all earth materials. Earth materials can be divided into the lithosphere, hydrosphere and atmosphere.

The hydrosphere, lithosphere and atmosphere are made up of liquids (water), solids (land) and gases (air). The changing surface of the Earth is a product of material movement, and the transporting agents for change are the hydrosphere, lithosphere and atmosphere.

Changes in the land surface of the Earth result from the interaction of moving air, water and other transporting agents. Loose materials are picked up, moved and deposited as sediments elsewhere.

TEACHER DIRECTION

E - 1

HYDROSPHERE, LITHOSPHERE AND ATMOSPHERE

Materials for groups of three:

1. 2 sheets of filter paper
2. Funnel (4 inch)
3. Sheet of white paper
4. Pond water
5. Eyedropper

The students are to see only indications of moisture in sand (lithosphere), solids in pond water (hydrosphere) and solids in air (atmosphere). The activity will be simple, dramatic and short to allow time for discussion. The activity should be part of a close discussion and proceed as directed by the instructor. Use transparency E-1 of the ocean and coastline.

THE PEOPLE THAT HAVE STUDIED THE EARTH TRIED TO DIVIDE THE EARTH INTO THREE PARTS. THE LAND -- Write LAND on the seashore section of the transparency. THE

Teacher Direction
page 2

WATER--Write WATER on the ocean section of the transparency. THE ATMOSPHERE-Write AIR first then ATMOSPHERE on the atmosphere section of the transparency. (Do not use the term hydrosphere or lithosphere). WHY DO YOU THINK THESE WERE THE FIRST THREE PARTS? Discussion

The discussion may lead many directions such as the animal life relationship of "birds fly", "fish swim" and "Man walks". The main point to stress is that the three categories are usually easy to recognize, but interrelated. There is water in the air, land particles in the water, and water in the land.

IS A SHALLOW LAKE AIR, WATER, OR LAND? Discussion. IS THERE AIR (ATMOSPHERE) IN THE OCEAN (HYDROSPHERE)? Yes. ARE THERE PARTICLES OF SAND (LITHOSPHERE) IN THE OCEAN? Yes IS THERE DUST (SOLID MATERIAL) IN THE AIR (A GAS)? Yes. There is no natural pure land without water or air trapped within it, nor pure air, nor pure water.

IT IS IMPORTANT TO BE ABLE TO DETERMINE IF SOMETHING IS LAND, WATER, OR AIR. THE BEST WAY TO DECIDE IS WHETHER OR NOT IT"S A LIQUID, A SOLID, OR A GAS. HOWEVER, GASES ARE MIXED IN WATER AND LAND. LIQUIDS ARE MIXED IN GASES AND SOLIDS. Discussion. IF YOU DIG A WELL AND FIND WATER, WHERE COULD THE WATER HAVE COME FROM? COULD IT HAVE COME DOWN THROUGH THE LAND FROM ABOVE? COULD IT HAVE MOVED THROUGH THE LAND FROM A NEAR BY LAKE?

LAND IS THE SOLID EARTH CRUST. WOULD A SEASHORE BE LAND. Yes Discussion. WOULD THE SEASHORE BE LAND EVEN IF COVERED BY WATER DURING HIGH TIDE? Yes. Discussion. It is a solid part of the Earth's crust. WOULD THE BOTTOM OF A LAKE BE LAND? Yes. WHAT OTHER NAME COULD WE CALL LAND? LITHOSPHERE.

Write LITHOSPHERE on the transparency next to "land". After writing the term tell the students it is not important to remember the term nor write it down.

Teacher Direction
page 3

CAN YOU THINK OF ANY SOLID PARTS OF THE EARTH THAT ARE NOT LAND OR LITHOSPHERE? There are none. A good question is whether a glacier or the polar ice caps are land or water. (land) Ice is frozen water since it is a solid it maybe called a rock. An iceberg floating in the ocean is part of the hydrosphere the same as a little piece of sand in the ocean.

WATER IS A COMPLICATED SUBJECT. YOU CAN FIND WATER EVERYWHERE. HOW CAN YOU DETERMINE WHEN A BODY OF WATER IS NOT PART OF THE LAND OR LITHOSPHERE? LET'S SAY THAT THE WATER PORTIONS OF THE EARTH ARE PONDS, LAKES, STREAMS, RIVERS, SEAS, AND OCEANS ON THE EARTH'S SURFACE. BUT HOW ABOUT A PUDDLE OF WATER? IS IT A BODY OF WATER, OR IS IT SIMPLY SOME WATER COLLECTED ON THE LAND? A collection of water is not considered a body of water. IF AFTER A BIG RAIN, SMALL FISH ARE SEEN IN A LITTLE PUDDLE OF WATER, IS THIS LITHOSPHERE? No, the minnows are probably from a creek that overflowed.

YOU'LL NEVER GUESS WHAT SCIENTISTS CALL WATER BODIES. Pause. HYDROSPHERE. Write this word next to "water" on the transparency.

WOULD YOU SAY THE OCEAN IS A WATER BODY? HYDROSPHERE? Yes. WOULD YOU SAY THE ST. JOHN'S RIVER IS A WTER BODY? HYDROSPHERE? Yes. DO YOU THINK A DRIED-UP LAKE WOULD BE A WATER BODY? HYDROSPHERE? No. Land. If it fills with water for a long period of time, however, the water would be hydrosphere.

Solicit questions from the class. Use the terms hydrosphere and lithosphere frequently. Compliment student use of the terms.

WE HAVE ONE MORE OF THE THREE MAIN DIVISIONS TO DISCUSS. ATMOSPHERE. WHAT IS THE ATMOSPHERE? The air surrounding the Earth. Accept all statements.

Pass out E-1

Teacher Direction
page 4

WE KNOW THAT THE WATER BODIES CONTAIN DIRT, AND WE KNOW THE AIR CONTAINS DIRT, SO LET'S FIND OUT A WAY TO SHOW THIS. READ THE FIRST PART OF E-1 SILENTLY AS I READ IT ALOUD. Read all of it initially, then return and complete the activity.

Read E-1 aloud, then ask the students to follow as you demonstrate. The students are to dampen the filter paper with an eyedropper without getting it dirty. Ask the students, after reading the directions and getting the paper wet, WHERE DOES DUST COME FROM? Air. GET SOME DUST FROM THE ATMOSPHERE ON THE FILTER PAPER AS DIRECTED BY THE ACTIVITY.

Pond water can be collected from any pond, or can be mixed by stirring in a handful of dirt with tap water. Collected pond water will be the best. An extension to this activity is to boil some pond water and ocean water, then compare the residues. It should be noted, however, that the residues are not always free land particles, but are residues that chemically form as the result of evaporation.

STUDENT E - 1

## HYDROSPHERE, ATMOSPHERE AND LITHOSPHERE

Materials for groups of three

1. 2 pieces of filter paper
2. Funnel (r inch)
3. Squirt bottle
4. Pond water
5. Sheet white paper

The study of our Earth is like studying a great big city full of people. Everybody looks different in some ways, but yet everybody has something similar. Some people like to laugh and play, others are quiet and stay indoors. The Earth is the same way. Parts of it such as rivers and oceans seem to be active, always moving or rushing somewhere. The land on the other hand seems to just sit around quietly. The wind in the atmosphere appears at times to be strong, active and destructive. Occasionally, such as early morning, it's quiet.

Early scientists recognized the three major parts of the Earth: land, water, and atmosphere. As scientists have always done, they gave each part a separate name. As you know, they called the air "atmosphere", the land they called "lithosphere", and the large bodies of water were called the "hydrosphere".

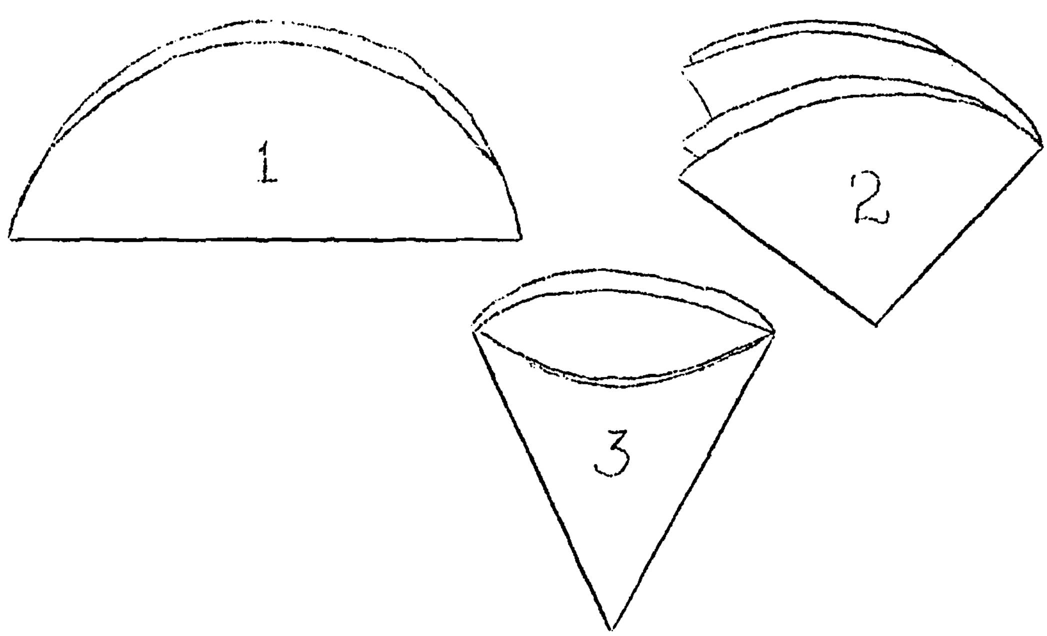
The three parts of the Earth—land, air, and water—seemed rather simple, but a great confusion arose. In the waters they found parts of land in the form of small bits of dirt. The air also had dirt in it. And yes, the land had air and water in it.

You can easily see this, but to explain it is difficult. This activity is for you to show that there is dirt (land material) in pond water and in air. Try to explain how it got there.

Student
Page 2

A. TO SHOW THAT DIRT IS PRESENT IN POND OR RIVER WATER, pour some pond or river water through a filter and examine what collects on the filter. The steps to follow are:

1. Fold a piece of filter paper two ways, dampen it, and place it in a funnel as shown in the diagram.




2. Pour the water through the filter. Be careful not to let the water rise above the paper edge.

Examine the filter paper to see what you have on it. Draw the material you have collected and label the parts as land, plants or animals.

Student
Page 3

How do you think these materials became mixed in the water? ____________________

________________________________________________________________________________

B. TO SEE IF THERE IS DIRT (SOLID MATERIAL IN THE AIR):

1. Rub some moist paper over a window sill or table that has not been dusted in a few days, 2. Carry a moist sheet of white paper around the room near the floor, or near the sidewalks, moving the flat side of the sheet forward. Examine the sheets to see what you have collected. Draw and label the parts as land, plants, or animals.

How do you think these materials became mixed in the air?______________________

________________________________________________________________________________

After completing the A and B parts of the activity, look at the papers and drawings.

1. Do they all have land on them?___________________________________________
2. Do they all have plants on them? _________________________________________
3. Do they all have animals on them?_________________________________________
4. How did dirt, or dust, get in the air or water?__________________________

Student
Page 4

5. Did the dust you collected come from the lithosphere?____________________

6. Where did the dirt come from? Jacksonville, New York, the ocean, the land or can you tell?________________________________________

7. Does the land look like the dirt outside of your classroom? A good way to find out is to mix some dirt from outside your classroom in water, then filter it, then compare it with the filter paper used with the pond water.

TEACHER DIRECTION E - 2

AIR IN LAND AND WATER

Materials for groups of three:

1. Beaker (400 ml) or tumbler
2. Porous rock (sandstone, coquina)
3. Soil
4. Erlenmeyer flask (250 ml)
5. Wire gauze
6. Burner (alcohol or bunsen)
7. Rind stand
8. Water (pond, river, or lake)

The purpose of this activity is to have the students discover that there is air in the solid materials of the Earth (lithosphere) and that there is air in the water on the Earth (hydrosphere). They can discover these facts easier by dropping some porous rock material in water and observing the air bubbles rise, and by driving air out of water by heating it. Bubbles of air will rise.

IT WAS SHOWN IN ACTIVITY 1 THAT POND WATER CONTAINS LAND MATERIAL. IN THIS ACTIVITY, WE WILL FIND OUT IF LAND MATERIALS CONTAIN AIR AND IF WATER CONTAINS AIR. ALL ROCKS AND WATER BODIES CONTAIN AIR. THE MORE POROUS THE LAND MATERIAL, THE MORE AIR. THE COLDER THE WATER, THE MORE AIR IT CONTAIN AS DEMONSTRATED BY BOILING WATER - BUBBLES FORM AND AIR IS RELEASED, OR ICE CUBES CONTAIN MORE AIR AND IS MORE POROUS THAN THE LIQUID STAGE.

Pass out E-2.

Read the directions with the students to determine if there is air in rock materials. Discuss the procedures while using transparency E-2.

Then read the directions with the students for finding out if there is air in water. Discuss the procedures while using transparency E-2a

Have the students do the activities. Circulate among them offering assistance.

Prior to the end of the period, have the students assemble and discuss as a class their findings, while showing the transparencies.

STUDENT ; E - 2

AIR IN LAND AND WATER

Materials for groups of three:

1. Beaker (400 ml)
2. Porous rock (sandstone, coquina
3. Soil
4. Erlenmeyer flask (250 ml)
5. Wire gauze
6. Burner (alcohol or bunsen)
7. Ring stand
8. Water (pond, river, or lake)

We have seen that water is present in the solid parts of the Earth (lithosphere). Is air also present in the lithosphere?

A. To find out if air is present in the solid and loose rock materials, drop a piece of rock in a beaker and some soil in another beaker of water. If air is present, the water will force it out and you will see bubbles of air rising through the water.


1. Did bubbles of air rise from the rock when you put it in the beaker of water?________________

2. Did bubbles of air rise from the soil when you put it in water?__________

3. Then would you say that air from the atmosphere is mixed with the solid part of the Earth (lithosphere)?____________________________

Student
Page 2

B. Do you suppose that air is present in water, too? Fish, which live in water, need air to live just as we do, don't they? How could we find out if there is air in water? Perhaps we could heat the water and drive off any air present in this way. If there is air in water, then bubbles of air should form on the beaker before the water begins to boil. Let's heat some lake water and see if bubbles do form on the glass before the water begins to boil. If they do, then we have demonstrated the presence of air in water.

1. Did bubbles of air rise from the water?____________________

   Would hot water contain more or less air?____________________

   How can you tell?____________________

   Why would frozen water float?____________________

2. Did bubbles of air collect on the sides of the beaker before the water started to boil?____________________

3. On what part of the beaker did they collect?____________________

4. Were they large bubbles or small bubbles?____________________

5. When the water started to boil, where did the bubbles of water vapor (steam) form?____________________

6. Were they on the sides of the beaker or on the bottom of the beaker?

   ____________________

7. Were they large bubbles or were they small bubbles?____________________

Topic 2 - Temperature is a measure of hotness and coldness. Both Fahrenheit and Centigrade scales are commonly used in measuring temperatures.

TEACHER DIRECTION E - 3

TEMPERATURE

Materials for groups of three:

1. 250 ml beaker
2. Thermometer
3. Ice
4. Bunsen burner
5. Ring stand

These activities are designed to develop skill in measuring and recording temperatures. The students will find at what temperature solid water becomes liquid, and liquid becomes gas. They will also compare the Centigrade and Fahrenheit scales.

Do not be surprised if the students do not know which end of the thermometer to submerge for reading. Some students will have trouble locating the mercury column. The following activities will develop confidence by letting the students discover how to read the scales.

Caution students that these thermometers are not to be used as oral thermometers. The thermometer is not to be allowed to rest on the bottom of the beaker while the beaker is being heated (it will break).

WE HAVE TALKED ABOUT HEAT AND SEVERAL OF YOU HAVE MENTIONED TEMPERATURE. SO LET'S DO SOME WORK WITH TEMPERATURE. (Pass out the thermometers). WHAT DO YOU CALL THAT THING I JUST GAVE YOU? Thermometer. WHAT DO YOU DO WITH A THERMOMETER? Accept all answers, but challenge any statement regarding heat by answering that heat is energy and must go from a hot area to a cold area, so what must temperature indicate? It indicates the direction of flow of heat. At the most opportune time continue with, LET'S DEFINE TEMPERATURE AS THE DEGREE OF HOTNESS OR COLDNESS.

Teacher Direction
page 2

NOW, LOOKING AT YOUR THERMOMETER, HOW HOT IS IT IN THIS ROOM? Place transparency E-3 on the overhead projector. Record all suggestions of temperature on the appropriate scale.

Accept all answers. Promote discussion among the groups. Ask one group to check another group's reading. It will be most appropriate if you can ask a group that is giving Fahrenheit readings to check another group that is reading the Centigrade scale.

EVERYONE LOOK AT THE TOP OF THE THERMOMETER. FIND THE LETTER "C" AND "F" Pause.

WHAT DOES THE "C" STAND FOR? Centigrade. WHAT DOES THE "F" STAND FOR? Fahrenheit. THESE SCALES ARE TWO WAYS TO READ TEMPERATURE. IT JUST TELLS YOU HOW HOT OR HOW COLD THINGS ARE. LET'S SEE WHO ARE THE HOTTEST, BOYS OR GIRLS? GRIP THE THERMOMETER IN YOUR HAND. THREE MINUTES FROM NOW WE WILL TAKE A READING. Decide what scale to read during these three minutes. WHICH SCALE DO YOU WANT TO READ? CENTIGRADE OR FAHRENHEIT? (Discussion) After time is up, average all the girls' readings and all the boys' readings. Repeat the activity placing the thermometer in the bend of the elbow using the opposite scale. Stress the use of Fahrenheit since this is the most commonly used in the community. Make sure the students are proficient in reading both Centigrade and Fahrenheit scales.

AT WHAT TEMPERATURE DOES WATER FREEZE TO BECOME ICE? (About $32^{o}$F or $0^{o}$C.) Accept all answers, but do not tell the students the correct answer. LET'S FIND OUT.

Pass out E-3.

Teacher Direction
page 3

The students are to determine the freezing point and boiling point of water. They are also to take a reading every minute.

The students may use the thermometer for a stirring rod, but they are not to leave the thermometer in the water without moving it. Caution the students to take readings accurately at one-minute intervals.

The beakers are to be one-third full of ice water with only a small quantity of crushed ice to reduce the temperature of the water to the freezing point. When the temperature cools to 32°F, have the students remove all but one tiny piece of ice. Timing and heating should start when the temperature is approximately 32°F and a small quantity of ice remains.

After completion, go over the data using transparency E-3, by writing in the times of each reading between the Centigrade and Fahrenheit readings. Students are to follow using page 2 of E-3.

An extra and interesting activity is to let the students go outside and record temperature in different localities. A marked difference can be shown in the following?

1. Shaded as compared to unshaded areas.
2. Different colored soils.
3. Different types of materials such as steel and wood.
4. Soils next to a pond or stream compared to soils away from streams.

STUDENT

E - 3

TEMPERATURE

Materials for groups of three:

1. Thermometer
2. 250 ml beaker
3. Small quantity of ice
4. Bunsen burner
5. Ring stand

Temperature is a measure of hotness of an object. We know that if we put ice in water, the temperature should drop to about 32° Fahrenheit and remain at this temperature as long as ice is present. This activity will show that the melting ice will cause the temperature of water to drop to about 32°F, the freezing point of water. Then by heating the water, we can determine the boiling point of water. In this activity we will experiment with measuring and recording temperatures.

The procedure must be followed carefully. Add ice water to the beaker until it is one-third full. Add a small piece of ice and stir it slowly and carefully with the thermometer until the temperature reaches 32°F. While waiting for the temperature to drop, adjust the ring stand to the proper height and light the burner. When the temperature drops to 32°F, record the exact time, minute and second in the table on the next page. Remove all but a tiny piece of ice and place the beaker on the ring stand over the bunsen burner.

While the water is heating, stir slowly with the thermometer. Do not ever let the thermometer rest on the bottom of the beaker; this may damage the thermometer.

To complete the table, you must take a reading every minute and record the temperature in the proper space on the chart. Do be accurate.

Student
Page 2

Complete the table below. Be sure the temperature is recorded in the proper space under the correct time interval

FREEZING TO BOILING

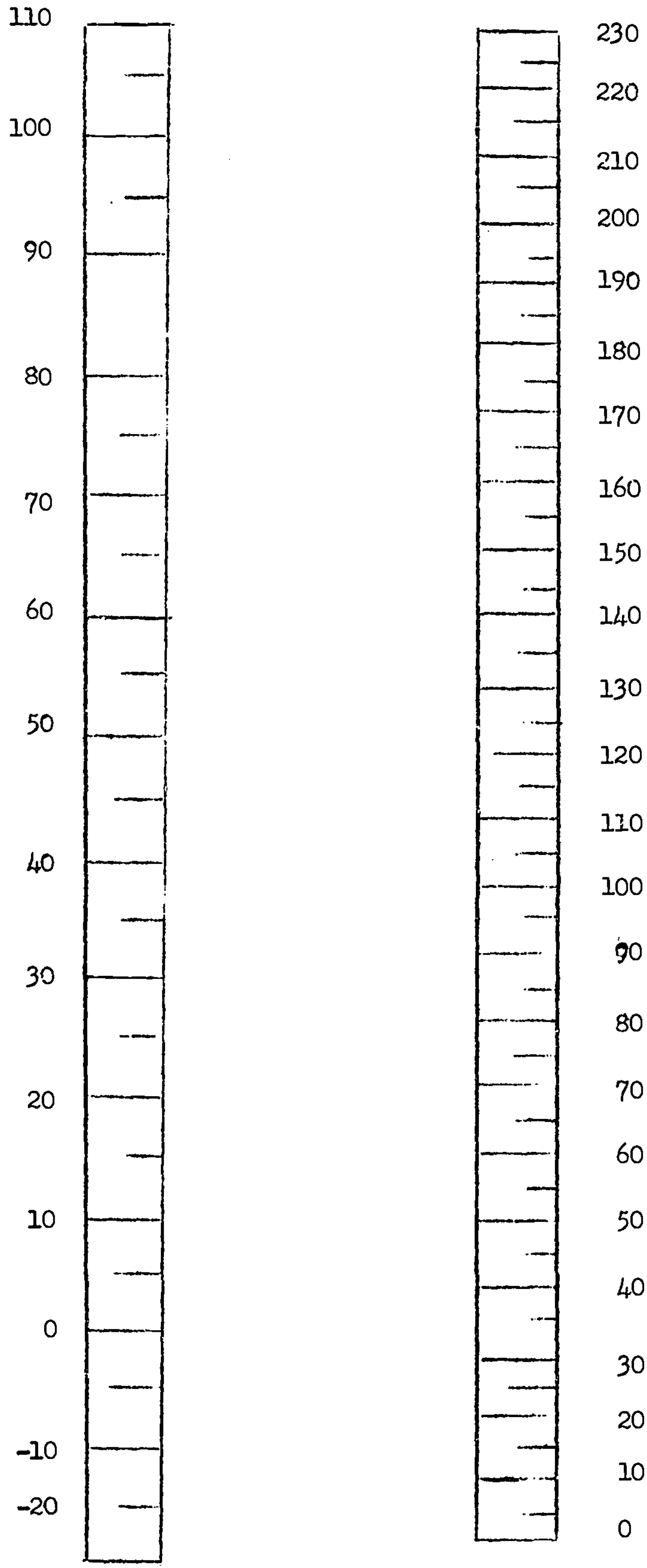
Intervals in Minutes

| MINUTES | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TEMPERATURE (FAHRENHEIT) | | | | | | | | | | | | | | | | |
| TIME | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
| TEMPERATURE (FAHRENHEIT) | | | | | | | | | | | | | | | | |

Student
Page 3

C

F



Topic 3 - Changes on the Earth are caused by energy.

TEACHER RESOURCE

It is the radiant energy from the sun which falls unequally on the Earth's surface that sets up currents in the waters and in the air. These currents distribute this energy, continually warming the polar regions and cooling tropical regions. The rotation of the Earth also affects these currents. It is easy to understand how heat energy is distributed by currents if one focuses his attention on local air and water currents. One can begin with the circulation of air around a bonfire, or in a room being heated with a stove, or with the way the heat energy from a stove warms the water in a container, or with the way the warm water in a lake cools in the fall of the year.

Heat energy moves from a region of higher temperature toward a region of lower temperature. Air and water currents will not flow if the region of higher temperature (hotter) is above the lower temperature (cooler). This is because gravity attracts heavier, colder substances with a stronger pull than warmer, lighter materials.

Thus it is seen that the cooler water at the bottom of a lake cannot be warmed by currents set up as the energy from the sun warms the surface of the lake. As the surface waters become warmer, they become lighter, and so remain at the surface of the lake. Perhaps you have noticed this when diving into a deep lake in the summer. You probably noticed that, as you went deeper, the water became cooler. Of course, during the entire summer the bottom waters do warm by radiant energy and by conduction, and to a limited extent due to mixing during storms.

Since wind and water currents are two of the chief agents that cause changes in the Earth's surface, it is appropriate at this time to see how heat energy makes these currents. Currents in the air are formed as the Earth warms the lower atmosphere, which is then pushed upwards by cooler air blowing in and forcing it upwards.

TEACHER DIRECTION E - 4

HOW CURRENTS CARRY HEAT ENERGY IN WATER AND IN AIR

Materials for groups of three:

1. 2 gas bottles
2. Dye (congo red or food dye)
3. Bunsen burner
4. 1 index card (3" x 5")
5. 2 beakers (400 ml)
6. Ring stand

This activity is planned to show that when the bottom of a liquid (water) or the bottom of a gas (air) near the Earth's surface is warmed, currents will be caused which carry the warmer materials upward.

Use transparency E-4 and a demonstration apparatus.

TO SEE HOW HEAT TRAVELS IN LIQUIDS SUCH AS WATER, FILL A WIDE MOUTH BOTTLE WITH COLD WATER AND ANOTHER ONE WITH HOT WATER. ADD SOME LYE (CONGO RED) TO THE HOT WATER. THEN PLACE AN INDEX CARD OVER THE MOUTH OF THE BOTTLE FILLED WITH HOT WATER. THEN PLACE IT OVER THE BOTTLE FILLED WITH COLD WATER. PULL OUT THE PAPER SEPARATING THE TWO. Discussion. WILL THE HOT WATER MIX WITH THE COLD WATER, OR WILL IT REMAIN ON TOP? YOU WILL FIND OUT WHEN YOU DO THE NEXT ACTIVITY. NOW, INVERT THE BOTTLES BY HOLDING ONE HAND TIGHTLY AROUND THE NECK OF BOTH BOTTLES, AND TURNING WITH THE OTHER HAND. THIS PLACED THE HOT WATER BENEATH THE COLD WATER. DO YOU THINK IT WILL MIX? FIND OUT THE ANSWER AS YOU DO THE NEXT ACTIVITY. LOOK AT THE DIAGRAM SHOWN ON THE TRANSPARENCY. ARE THERE ANY QUESTIONS ABOUT HOW TO CARRY OUT THIS INVESTIGATION?

Pass out E-4

Read the student directions (E-4) with the students. Ask questions about the procedure to be sure each group knows what to do.

Upon completion of the activity, reassemble for a class discussion. While using transparency E-4 for illustration, have students tell what happened. The heat energy is always carried upwards. When the cold water is placed on top, the heavier cold water moves downward, forcing the lighter hot water upwards.

STUDENT

## HOW CURRENTS CARRY HEAT ENERGY IN WATER AND IN AIR

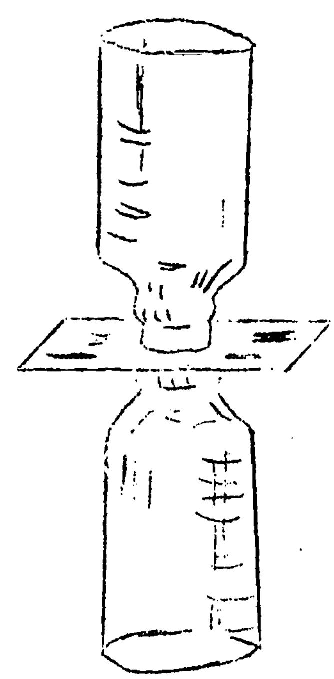
Materials for groups of three:

1. 2 gas bottles
2. Dye (conge red)
3. Alcohol burner
4. 2 beakers (400 ml)
5. Index card (3" x 5")
6. Ring stand

Temperature is a measure of how hot or cold something is. The temperature can be measured with a thermometer, as you know. In this investigation, use the Fahrenheit scale, marked F. When heat energy moves upward in liquids such as water, it moves from the hotter to the colder liquid. In this activity, you are to find if this statement is true.

To see if heat energy is carried upwards, not downwards, by currents in liquids, proceed as directed.

Fill one bottle with cold water. Fill the second bottle with hot water and add dye for color. If hot water is not readily available, heat some in a beaker to about 150°F. Place an index card over the mouth of the bottle containing hot water, turn it upside down, and place it over the mouth of the bottle containing cold water, as shown in the illustration. Remove the paper and watch for several minutes.



TEACHER DIRECTION E - 5

EFFECTS OF TEMPERATURE ON SOLIDS IN THE HYDROSPHERE

Materials for groups of three:

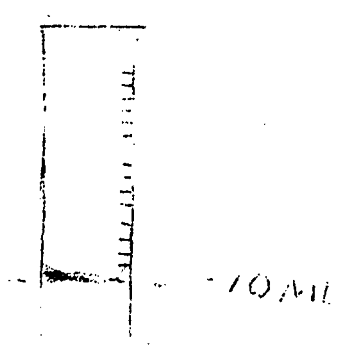
1. Dry ice
2. Funnel (4 inches)
3. Dirt (20 ml)
4. 2 beakers (250 ml)
5. Graduated cylinder (100 ml)
6. 3 pieces of filter paper (9cm)

The students are to use dry ice (solid $CO_2$) to provide a wide difference in temperature for a dramatic deposition activity. Crushed ice may be substituted for dry ice, but results will not be as striking. The use of crushed ice will require more time than dry ice for observable results.

The muddy water can be prepared by mixing soil in water with a low organic content and with a high clay content. Any soil sample will be adequate if pebbles are removed. When mixing the soil and water, stir vigorously for two minutes to put the clay into suspension. After stirring, the liquid portion should be cloudy in appearance for best results. The ten minute waiting period after stirring is to allow the larger particles to settle out, leaving only the finer particles in suspension. WHAT WOULD HAPPEN TO MUDDY WATER IF IT BECAME COLDER? Discussion. Do not tell the students the answer.

Pass out E-5

Using transparency E-5, read the student directions for E-5 with the class and discuss the procedure. The terms "lithosphere" and "appearance" should be explained. In explaining the terms, avoid the word "define"



Teacher Direction
page 2

An explanation for locating the 10 ml line on the graduated cylinder will be needed. Packing the dirt in the cylinder is not necessary. The explanation to locate the 10 ml line is not to involve the overall discussion of the metric system. Do not mention the term "metric" and do not discuss it unless a student raises questions, and then only answer the specific question. The students will learn the metric system easier by working with it rather then working problems in metric relations.

Upon completion of E-5, reassemble for a class discussion. Instruct the students to have their activity completed. Use transparency E-5 to lead the discussion. Fill in observations 1, 2, and 3 on the transparency. If a wide degree of differences exist, demonstrate the activity as you fill in the transparency. Differences in techniques can produce wide differences in results. In the discussion, emphasize technique and the effort of temperature on natural processes of deposition. The major processes to emphasize are:

1. The water transports fine, solid materials in the lithosphere by carrying "floating" particles in suspension.
2. The water transports the larger materials that settle out by dragging them along the bottom along with the current.
3. The particles carried by the water can be wind blown from the atmosphere, or washed in by water moving rapidly over loose soil.
4. Materials are deposited more rapidly when the temperature is low.
5. Currents in the hydrosphere are changing the shape of the lithosphere.

STUDENT

E - 5

# EFFECTS OF TEMPERATURE ON SOLIDS IN THE HYDROSPHERE

Materials for groups of three:

1. Dry ice
2. 2 beakers (250 ml)
3. Graduated cylinder (100 ml)
4. Dirt (20 ml)
5. 2 funnels (4 in)
6. 3 pieces filter paper (9 cm)
7. 2 waste bottles (6 oz gas bottles)

Temperature has many effects on the hydrosphere. In this activity you will see the effect of a low temperature on the formation of an example lithosphere (laboratory style). You will see the effect of a cold temperature on the rate that the dirt will settle and on the quantity of the dirt that will settle. Some of the dirt will float giving the water a cloudy appearance.

To observe these effects of temperature on settling of solid materials in water, you are to put dirt in each one of the beakers with dry ice. To get good observations, follow these steps closely:

1. Number the beakers 1 and 2.
2. Number two sheets of filter paper 1 and 2.
3. Add water to the beakers until each is 3/4 full.
4. Add 10 ml of dirt to each beaker and stir for about one minute. Make and record observation number 1.
5. Set one of the beakers on the table and set the other beaker on a piece of dry ice. Allow the dirt to settle in each beaker for ten minutes. While waiting for the dirt and particles to settle, fold and place filter paper number 1 in one funnel and filter paper number 2 in another funnel.
6. After waiting ten minutes for the particles to settle make observation number 2. Record your findings in the space provided.

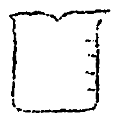
Student
Page 2

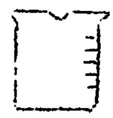
OBSERVATION NUMBER 1

Clear________

Cloudy________

Muddy________





________ Clear

________ Cloudy

________ Muddy

______________________________________________________________

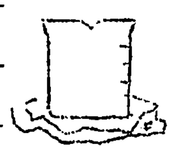
______________________________________________________________

OBSERVATION NUMBER 2

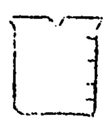
Clear__________

Cloudy__________

Muddy __________



DRY ICE



________ Clear

________ Cloudy

________ Muddy

7. To compare the amount of dirt left suspended in each beaker, filter $\frac{1}{2}$ of the water from each beaker being careful not to pour any of the settled material in the funnel. Use filter paper number 1 for beaker number 1, and use filter paper number 2 for beaker number 2.

8. Remove the filter paper from the funnel, unfold it, and let it dry briefly. In which beaker was the most dirt left suspended in the water?__________________

How do you account for this result?______________________________________

______________________________________________________________

Student
Page 3

For observation number 3, draw the filter paper as it appears after filtering the water.

OBSERVATION NUMBER 3

Drawing of filter paper number 1

Drawing of filter paper number 2

Topic 5 - Precipitation of materials from a liquid can be accomplished by centrifugal action and chemical changes.

Whirling is centrifugal action. Do not use the term "centrifuge" without using the words "whirl" or "rotate".

The heavier particles will settle first, followed in sequence according to weight. This cannot be shown in this activity because most of the suspended particles are the same size.

TEACHER DIRECTION E - 6

CENTRIFUGAL FORCE

Materials for groups of three:

1. Beaker (250 ml)
2. 2 test tubes
3. Test tube rack
4. Dirt (10 ml)
5. String (18 inches)
6. Masking tape

Running water in oceans and rivers do not exhibit a centrifugal action in the laboratory activity. The activity is to demonstrate another process to precipitate solids from suspensions.

Make a demonstration centrifuge apparatus to spin as you introduce the activity. The apparatus can be made of string and a test tube by tying a slip knot in the center of the string, inserting the test tube, and wrapping masking tape around the string and test tube to prevent the string from slipping.

Teacher Direction
page 2

The dirt suspension is to be prepared as in E-5. The laboratory implications are to be stressed. Have water and dirt in the centrifuge as you start the discussion. SCIENTISTS ARE INTERESTED IN USING LABORATORY TESTS TO MAKE PREDICTIONS. THE NEXT ACTIVITY IS TO SHOW ONE OF THESE TESTS USED TO SEPARATE SUSPENDED SOLIDS FROM WATER. Start whirling the demonstration apparatus for interest. WILL THE WATER SPILL OUT AS LONG AS I KEEP WHIRLING THIS TEST TUBE? No. WHY? Discussion. The water and material in the test tube are pushed against the bottom of the test tube. IF THE WATER AND MATERIALS ARE BEING PUSHED AGAINST THE BOTTOM OF THE TEST TUBE, WHAT WILL THE DIRT AND MATERIALS IN THE WATER DO? Go to the bottom of the test tube. THIS IMPORTANT TECHNIQUE IS CALLED CENTRIFUGATION. LET'S DO SOME OF IT.

Pass out E-6

Instruct the students to follow your directions closely in assembling the centrifuge. Use transparency E-6 and have the students assemble their centrifuges. Upon completion of assembling the apparatus, discuss the student directions in E-6 and let the students work independently. Give as few specific instructions as possible, but do provide sufficient information to insure success. The term "suspension" may need to be explained.

Upon completion of the activity, reassemble for a class discussion. Use transparency E-6a to discuss the results.

STUDENT E - 6

CENTRIFUGAL FORCE

Materials for groups of three:

1. Beaker (250 ml)
2. 2 test tubes
3. Test tube rack or beaker
4. Dirt (10 ml)
5. string (18 inches)
6. Masking tape

After one has observed a particular condition or change, he frequently asks the question, "To what extent has this occurred?" Then he turns to the laboratory to measure the extent of the condition or change. A centrifuge is frequently used to separate the solid or heavier materials of a mixture from the liquid or lighter materials. When one separates materials by a centrifuge, he whirls, or centrifuges, the materials rapidly. The heavier, denser materials move into the outside and the lighter materials move toward the center. In dairies, the lighter cream is separated from the heavier portions, the skim milk, by this process. This process acts to separate the parts of the mixture much like a settling process, but it acts much faster and is so useful in the laboratory. We shall use it today to separate suspended solids from dirty water. In this same way we could measure the amount of suspended material being moved by a river.

To separate suspended dirt from dirty water, first make some dirty water by putting some soil in water and allowing it to settle for a few minutes as you did in E-5. Then pour water from the mixture into each of two test tubes until they are about $\frac{1}{2}$ full. (Use care not to pour any of the dirt which has settled out from the mixture.)

Number each test tube.

Tie a string to test tube number 2 and whirl it rapidly for a least three minutes as shown in the illustration. The faster you whirl and the longer you whirl it, the better the separation should be.

TEACHER DIRECTION E - 7

PRECIPITATION DUE TO CHEMICAL ACTION

Materials for groups of three:

1. 2 beakers
2. Dirt (10 ml)
3. Alum crystals (20 ml)
4. Graduated cylinder (100 ml)

The addition of alum to a suspension of dirt in water will cause the solids to precipitate. The alum will act as an adhesive to stick the small solid material together and form large particles which will settle out due to their weight. Precipitation will probably occur within minutes after adding the alum.

The rivers, streams, and oceans flow through different regions and new chemicals added to the water can cause some materials to be deposited. A laboratory beaker can simulate the actions of a strata containing alum in the earth as it reacts with the sediments of a river.

The dirt suspension is to be prepared as in E-5.

The laboratory implications are to be stressed. Deposition due to alum is not geologically significant. The precipitation of deposits due to size of the particles is significant. The size of a particle and its distance of transportation to a location of deposition is important. The local conditions determine if deposition will occur; rate of transport by wind or water, chemicals contributed to the transporting medium, temperature, and the size of the material being transported are factors affecting deposition.

MATERIALS CARRIED BY WATER MAY BE CARRIED FOR A SHORT DISTANCE, OR VERY FAR. THE MOVEMENT OF MATERIAL CAUSES THE EARTH'S SURFACE TO CHANGE. IT IS INTERESTING TO FIND WHERE THE MATERIAL WILL BE DEPOSITED. WHAT ARE SOME OF THE CONDITIONS THAT WILL CAUSE MATERIALS TO BE DEPOSITED? Discussion. Temperature change, whirling action, reduced rate of flow, chemical action, size and density of the particles being transported, are all factors which affect the rate of deposition.

Teacher Direction
page 2

THE CONDITIONS CAUSING MATERIALS TO BE DEPOSITED ARE NUMEROUS. LET'S INVESTIGATE THE DEPOSITING OF A MATERIAL THROUGH CHEMICAL ACTION.

Perform the demonstration.

Materials for demonstration:

1. Sulfuric acid ($H_2SO_4$)
2. Barium chloride ($BACL_2$)
3. Beaker (250 ml)
4. Eye dropper pipette

Do not tell the students what the chemicals are until the demonstration is completed.

Using a beaker three-fourths full of diluted sulfuric acid, add drops of barium chloride slowly. A white solid, barium sulfate, will precipitate. If the students cannot see well, let them gather around the demonstration, but use caution with acid present.

As the precipitate forms and sinks to the bottom, ask the students to explain what causes the precipitate to form--chemical reaction. Ask why the precipitate sinks--size and density of the particles. Do not try to explain the molecular relations. Stress the change of chemical composition and how the size and density of particles affect deposition. The chemical content in the hydrosphere continually changes as water flows from one area to another. Make sure everyone understands the ideas related to chemical change and weight before passing out the student activity. Leave the demonstration set up for class discussion until completion of the student activity.

Teacher Direction
page 3

Pass out E-7

Read the student directions aloud as the students read silently; answer all questions. The students are to mix dirt and water as in E-5. Mix 20 ml of dirt in 200 ml of water, then stir for one minute, then pour the suspension into another beaker. Use care not to let any of the dirt pour into the beaker with the liquid suspension. Add 20 ml of alum crystals to the solution.

Upon completion of the activity, discuss the results, referring to the demonstration and the activity. Do not involve the technicalities of molecular reaction unless questions are asked.

STUDENT E - 7

PRECIPITATION DUE TO CHEMICAL ACTION

Materials for groups of three:

1. 2 beakers
2. Dirt (10 ml)
3. Alum crystals (20 ml)
4. Graduated cylinder (100 ml)

The flow of a river seems to be endless. One wonders as he sees the water flow, where does the water come from and how far has the water been flowing? It may be a few miles or the full length of the continent. It might have been an underground river at one time, or perhaps some of the water is rain that fell less than a mile away. As one wonders, he can imagine many things. Did the water come from a small mountain stream that ran into a river then rushed to the ocean? Or, did the water originate from a heavy snow that melted?

One thing we do know. As water flows in the streams, rivers, or oceans it is constantly exposed to different conditions--different temperatures, mixing streams, contamination, different materials under the water, etc.

In this activity you are to observe a chemical change that could cause materials to be deposited. Compare your observation with the demonstration.

Mix 10 ml of dirt in 200 ml of water as you did in #-5. Remember to let the heavier materials settle after stirring. Then carefully pour the suspension into another beaker. (Use care not to pour any of the dirt which has settled out into the beaker with the mixture). Add 20 ml of powdered alum to the suspension.

1. What did the alum do?______________________________

Student
Page 2

2. Why did the dirt settle to the bottom?

3. What would happen if you put alum into a dirty swimming pool?

4. Name some use of alum.

TEACHER DIRECTION E - 8

AN IMAGINARY STORY OF THE

TRAVELS OF A DROP OF WATER

The purpose of this reading activity is to relate the idea that as water is transported it encounters many differing conditions.

This is the first reading activity. It must be a pleasant experience. Do not expect any factual retention or a comparison to previous activities by the students.

A suggested film to introduce the activity is Life in a Drop of Water. Discuss the film before passing out E-8.

The students are to read the activity, then the instructor should read it aloud. Relate the reading activity to previous activities and the film in order to encourage recall of past concepts.

Answer all questions at the end of the activity.

TEACHER DIRECTION E - 8

AN IMAGINARY STORY OF THE

TRAVELS OF A DROP OF WATER

The purpose of this reading activity is to relate the idea that as water is transported it encounters many differing conditions.

This is the first reading activity. It must be a pleasant expe ience. Do not expect any factual retention or a comparison to previous activities by the students.

A suggested film to introduce the activity is Life in a Drop of Water. Discuss the film before passing out E-8.

The students are to read the activity, then the instructor should read it aloud. Relate the reading activity to previous activities and the film in order to encourage recall of past concepts.

Answer all questions at the end of the activity.

STUDENT E - 8

AN IMAGINARY STORY OF THE
TRAVELS OF A DROP OF WATER

A little drop of water may be a world traveler many thousands of years old. He may have been imprisoned in a glacier as an ice crystal before being freed by the sun to run in the streams or rivers. Or, he may have traveled the oceans as an iceburg. Little drops of water are everywhere and if one could talk, you would probably hear a fascinating story.

A little water drop would probably tell a very sad story about destruction, filth, and prisons. He could, however, have been a cheerful drop of water that brought happiness, beauty and health. Let's imagine a "tale of woe" first.

One little drop of water was happily flying along the coast of Cuba when a strong wind caught him. It began whirling him viciously, and the wind cursed his existance. Waves in the oceans reared in revenge. Radio signals from Miami continually warned--"You are a hurricane". Finally, the little drop of water sees Jacksonville, Florida, and is hurled against a large rock. The rock seemed to melt a little when the drop hit. Then violently, the little drop was picked up again by the winds and carried north by the hurricane up the Carolina coast.

The little drop of water was finally released from the howling winds and was carried along in a cloud slowly towards Canda, heading towards the North Pole. Eventually the winds began to increase again and the little drop became a frozen crystal and fell on a glacier. He was cold for years, held in a slowly moving glacier. Finally, one day he started to get warm and was washed off of the glacier as a part of a big piece of ice. He was carried south in a fast moving, cold stream and dumped in a river. The ice melted and the little drop of water was rushing past huge forests, around bends in the river and over waterfalls.

Student
Page 2

Suddenly one day it ran into a large tree root and was absorbed. Trapped again. He stayed in the tree for several days until he was blown out a little hole in a leaf. He was once again flying along in the wind toward Florida. Eventually the winds became colder and he was thrown against the Earth. He sank slowly into the earth until he went through a black oily layer into salt water. He could go no further. He was a dirty little drop now, salty and stuck.

One day a big steel pipe punched a hole in the black layer and he was hurled into the air. Upon returning to the earth, he found himself in a peaceful lake.

What has the little drop missed. He missed being in a janitor's soap bucket. He missed the city gutters. He missed the city sewer.

Our little drop of water did a lot of good, however. As he was washed down the river basin that moves materials southward he carried some chemicals that eventually may reach the sea. Yes, our little drop of water made changes in the land sea.

What could a drop of water in the St. John's River say, that is if it could talk?

# UNIT 2

## WEATHER

This unit is designed to offer the students some experiences in affects and effects of weather. The role that water plays in weather will be investigated throughout the unit along with another all-important factor - wind. To make it more interesting, the students will be asked to log and predict weather on the basis of information gathered from news media and their own measurements. The hurricane season will be upon us, so some interesting predictions, and upsets due to excess winds, should be forthcoming.

The activities in this unit are:

| | |
|---|---|
| E-9 | WEATHER MAP<br>(Making a map from which to plot and predict the weather) |
| E-10 | BAROMETRIC PRESSURE<br>(Making a simple colored water barometer) |
| E-11 | HUMIDITY<br>(Making a psychrometer) |
| E-12 | WIND<br>(Measuring wind speed and direction) |
| E-13 | DEW POINT<br>(Forming dew on the outside of a cooling beaker) |
| E-14 | INVESTIGATING FROST<br>(Forming frost on the outside of a beaker) |
| E-15 | MAKING A CLOUD<br>(Forming a cloud in a bottle by blowing and releasing pressure) |
| E-16 | INVESTIGATING AIR<br>(Showing air has weight) |
| E-17 | FACTORS AFFECTING THE RATE OF EVAPORATION<br>(Wind, humidity, and heat) |
| E-18 | DUST IN THE AIR<br>(Detecting dust in the air) |

UNIT 2

WEATHER

The never ending recurrance of rainy, cloudy, windy, and clear days is the product of water evaporation and condensation. Energy from the sun, is absorbed by land and water, it causes the water to evaporate into the atmosphere. A model can be constructed by thinking of the earth as a large pan of water with solid land masses. The sun, acting like a stove, heats the large pan (earth) of water and land. Of course, some of the surrounding air is heated by the sun (or stove) but only a very little. As the pan becomes hotter, the water and land becomes hotter and the water evaporates, leaving the pan and going into the atmosphere where it cools. The reverse action takes place when the atmosphere cools and the water vapor changes to drops of water and returns to the pan as rain, dew, frost, sleet, or snow.

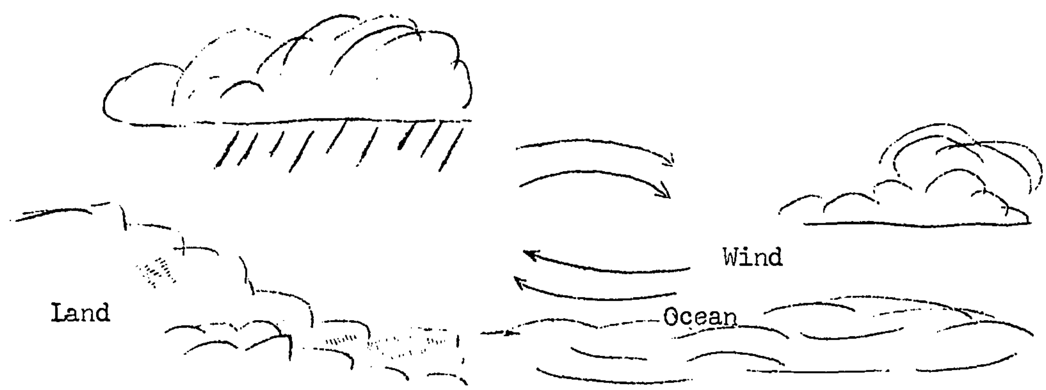
The sun heats the earth's land and water causing the water to evaporate. As water enters the air, it saturates the air. As the air loses its heat energy the water vapor condenses. This results in the formation of large water drops that return to the earth.

Water evaporates from warm moist surface into the air as water vapor. The water vapor will remain in the air as long as the air remains warm. When this warm moist air cools, as it does during winter evenings, some of the water vapor may condense as fog. Perhaps you've noticed that during the winter season, fog forms during the nights and that this fog disappears in the mid morning hours as the earth's surface is warmed. Thus, depending upon the amount of moisture in the air and the changes in temperature, water evaporates into the air becoming water vapor (a gas) or water vapor condenses out of the air as water drops (a liquid).

Energy from the sun evaporates water into the air. It also makes the wind blow. In this moisture from the oceans is carried over the land, where it falls as rain and snow. If this were not so the land would be dry and barren.

Teacher Resource
page 2

Wind is also an important factor in the amount of water the air absorbs. As the water evaporates from the earth's surface, the wind causes a churning action in the air, blows the moist air away from the evaporation area thus forcing the drier air into the evaporation area next to the earth where it absorbs more water. The water soaked air next moves upward and away as the drier air replaces it to absorb more water. When the air is saturated with water and becomes cooler, small droplets of water will form and fall to the earth as rain.




Examining the above diagram and previous statements, we can draw the following conclusion about rain clouds:

1. Rain clouds are found in the air where it is cooler.

2. Wind introduces warmer, dryer air to the surface forcing the moist air upward.

3. The degree of saturation of the air is dependent on the temperature of the air.

4. If wind does not blow in drier air and if the temperature close to the surface of the land drops, fog occurs.

Teacher Resource
Page 3

Historically, one of the most important discoveries of man, in relation to his association with weather, was the invention by Samuel Morse of the telegraph. It extended man's visual, local observations from a 10 to 20 mile area, to an enormous expanse covering continents thus allowing him to gather weather information from many distant sources.

The first weather map was published by the French in 1863 and followed by the United States in 1871. Since this time, the "weather map" has become important to all of us for aviation, maritime, commercial and even military combat planning. The first weather maps gave only the simplest information:

a. Temperature
b. Wind
c. Atmospheric Pressure
d. Precipitation (rain)

Modern, present-day weather maps, however, require about 250 specific symbols.

At the present time, our atmosphere is under constant surveillance, and is inspected thoroughly four times per day at about 300 major and 450 secondary weather stations in the United States, Canada, Mexico, West Indies, and also by aircraft in flight and ships at sea. The four daily inspections and probes occur at 1:30 a.m., 7:30 a.m., 1:30 p.m., and 7:30 p.m. Each of these inspections cover 7 aspects of clouds, the barometric pressure, direction and velocity of the wind, amount of precipitation, temperature, humidity, and mention occasional phenomena such as thunderstorms, fog, halos, and review past weather and pressure from 5,000 feet up.

Teacher Resource
Page 4

All of the data obtained are condensed into "Cipher" and sent to District Forecast Centers. At the District Forecast Center, all of this data is "Deciphered" and translated into a complete weather map and in the hands of all forecasters within 2 hours.

In order to present an accurate forecast, it is imperative that the meteorologist review the weather and its patterns over a 12 hour period concentrating on the air masses, frontal actions, precipitation areas, and atmospheric pressure. In compiling sufficient air pressure data, the observer can draw in the "isobars" - lines connecting stations with equal air pressures. This enables one to locate the "Pressure Patterns" and plot LOW and HIGH areas forming the basis for our "weather map." In the plotting of the "lows and highs" remember that the air circulation is "clockwise" around the "Low" and "counterclockwise" around the "High".

After the highs and lows have been plotted, the "fronts" an area where two different main air masses meet, are placed and referenced on the map in color:

1. Blue - A "Cold" front: a cold front is located by considering temperature, pressure, surface wind, dewpoint, the type of clouds and precipitation.

2. Red - A "Warm front is difficult to locate because the decrease in atmospheric pressure is slower in showing an indication than the pressure increases which indicates a "High" or "Cold Front". Standard atmospheric air pressure is 14.72 pounds per square inch. (p.s.i.)

A weather forecaster depends mainly on the movement and rate of travel of "highs" and "lows" for the area within which he is to predict the weather. These "highs" and "lows" usually continue to move at the same speed they moved during the last 12 hours. Thus the forecaster can estimate when a high or low can be expected in a particular area.

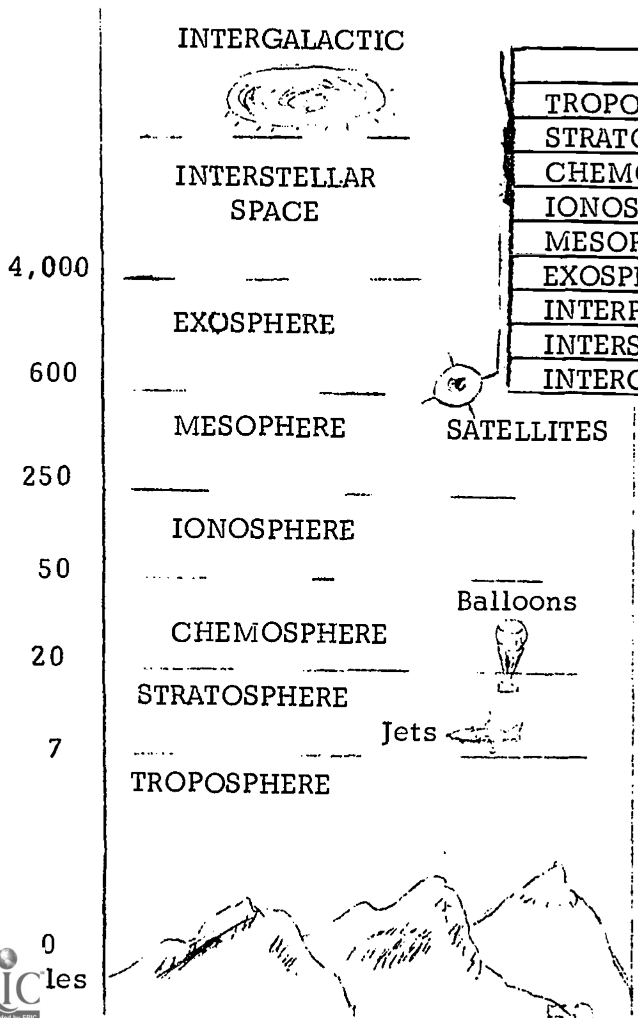
The types of clouds also help to locate a "warm front." A high dew point is characteristic of maritime air brought into the atmosphere by the "warm area"

Teacher Resource
Page 5

The atmosphere is always changing due to the influence of heat from the sun, rotation of the earth, the irregular surface of the earth, temperature difference, and ocean currents. The sun heats our earths surfaces; land, water, marshes, mountains, deserts and cities and air is literally "boiled" upwards and outwards as high as 10 miles.

The temperature we encounter within the atmosphere in which we live ranges from about 100 degrees F to -100 degrees F. The "Stratosphere", is somewhat colder, and has an absence of weather. The temperature in the Stratosphere ranges from -100 degrees F above the equator to somewhat warmer readings over the north and south poles. The temperature in the "Ionosphere" is about 1500 degrees F and highly ionized.

| AREA | DISTANCE |
|---|---|
| TROPOSHERE | 0-7 miles |
| STRATOSPHERE | 7-20 miles |
| CHEMOSPHERE | 20-50 miles |
| IONOSPHERE | 50-250 miles |
| MESOPHERE | 250-600 miles |
| EXOSPHERE | 600-4,000 miles |
| INTERPLANETARY SPACE | SPACE AMONG PLANETS |
| INTERSTELLAR SPACE | SPACE AMONG STARS |
| INTERGALACTIC SPACE | SPACE AMONG GALAXIES |




AREAS OF SPACE

Teacher Resource
page 6

In discussing air pressures, it might be mentioned that the normal air pressure is about 15 pounds per square inch (15 p.s.i.) at sea level. It must be understood that as one goes upwards the air pressure decreases and air gets thinner. You can clarify this by telling that a pilot who is flying above 10,000 feet must wear an oxygen mask or be inside a "pressurized" cabin filled with oxygen to breathe and his engines must be equipped with air "super-chargers" in order to obtain the proper air to fuel ratio for ignition. As a person climbs a mountain, the air pressure decreases and breathing becomes more difficult.

Air pressure at a particular location is due to the weight of the air above that location. Normal air pressure of15 p.s.i. means the weight of all the air, as high as the air goes above one square inch is 15 pounds. Cold air weighs more than hot air. So when the air above a particular location is cold the pressure at that location is greater than when it is warmer. The colder air being heavier tends to flow downward and spread out in all directions at the earth's surface. Thus air at the earth's surface blows as wind from high pressure centers toward low pressure centers. Remember how heat energy is distributed by convection currents, with the cold air settling down and forcing the hot air upwards. Unequal heating of the earth's surface makes differences in the air pressure at various locations.

Winds, like other moving objects, tend to keep on moving in the same direction they are moving. Since the earth is a rotating sphere, the eastward velocity of air near the equator is much greater than that in the north or to the south. At both poles there is no eastward motion. So a wind which is blowing northward from the equator tends to get a head of the earth's surface, and a wind blowing toward the north tends to get behind, thus in the northern hemisphere, surface winds veer to the right. This change in the direction of surface winds due to the rotation of the earth is known as the coriolis effect.

Teacher Resource
page 7

So called "land and sea breezes" a long the shore are due to the unequal heating and cooling of the land and water. The surface temperature of the land changes faster than that of the water. On cool summer evenings these winds usually blow from Jacksonville toward the ocean, and during warm summer days the cool breezes blow from the ocean toward Jacksonville.

Still another factor affecting the flow of air over the earth's surface is the shape of the land surface. Mountains and valleys modify the direction of flow.

In the U. S. major wind systems develop around the 30 degree latitude. Cold air settles down and flows northward and southward from this latitude.

The air which moves northward moves eastward due to the rotation of the earth from the wind belt known as the westerlies, more properly called southwesterlies. Winds are named according to the direction from which they come, thus a wind moving northeast is called a southwest wind. Winds flowing southward from the 30 degree latitude high pressure center flows south westerly. They are northeast winds. This belt of wind is known as the Trade Wind Belt. They are northeast winds and they blow continuously. These winds bring most of our summer weather.

During the winter months cold polar air masses from the north sometimes pushes all the way southward into Florida producing troublesome frosts.

Topic I - Weather is the physical condition of the atmosphere over a short period of time. Air masses drift causing changes in barometric pressure, temperature, humidity, wind and dew point that can be used to predict weather.

This main relationships to be stressed are the effects of temperature, the weight of air, and evaporation to the probability of rain. Weather is an observable phenomena which we try to predict with a measure of success. All activities are designed to determine cause and effect of these phenomena on weather predictability. The activities are short to allow discussions, and are to be used to develop a broad understanding of weather prediction.

Each group of students is to draw a map of the United States on an acetate, using a magic marker for permanency and keep a daily recording of the weather. A national weather report can be obtained from the local newspaper. Each of the following activities investigates a specific aspect of weather, which is to be recorded daily following the activity. Hopefully, students can make reasonable weather predictions upon completing this unit.

TEACHER DIRECTION E-9

WEATHER MAP

Materials for groups of three:

1. Overhead Transparency Marker 2. 3 Clear Acetates 3. Map of United States

A map of the United States is to be traced on each acetate. The students are to use this map daily to record national weather conditions. It is suggested that 6 cities across the nation be selected and daily data be recorded, temperature, rain and wind direction. All highs and lows are to be recorded, then when available any other information such as fronts, rain, and wind patterns.

Initiate the activity with a general discussion of what the weather has been during the last week. Did it rain? Was it clear? Was it Foggy? Was the wind blowing? Do not define "weather." Do not suggest weather is predictable, let the students determine this.

WHAT IS THE WEATHER TODAY? Accept all answers and make a list on an acetate? WHAT WAS THE WEATHER YESTERDAY? Make a similar list of answers. WHAT WILL THE WEATHER PROBABLY BE TOMORROW? Accept all answers. Use the word "probably" and "probability" whenever applicable. Do not ask the students to use the words, but compliment their use when used correctly.

LETS USE A SERIES OF WEATHER MAPS THAT WERE SPECIALLY PREPARED AND SEE IF WE CAN PREDICT THE WEATHER. Use transparency W-1.

Teacher Direction
Page 2

Discuss each acetate separately, draw in movement of the rain section from the Northwest into Florida. After each acetate predict when it will be clear in Jacksonville. There are two times - Sept. 2 and Sept. 3. This will demonstrate that following large weather patterns you can predict the weather for the near future.

Pass out E-9

YOU HAVE 3 ACETATES ON WHICH YOU ARE TO DRAW MAPS OF THE UNITED STATES. WE ARE GOING TO BECOME WEATHER FORECASTERS. IT WILL BE NECESSARY TO KNOW WHAT IS HAPPENING IN ALL PARTS OF THE UNITED STATES. WE WILL GET THIS INFORMATION FROM THE DAILY PAPER.

Read E-9 with the students and impress on them the importance of drawing the map accurately. State lines are to be drawn. Select six cities across the nation to identify; make sure these cities are listed in the paper. Identify these cities on a transparency of the United States using a numerical code of 1,2,3,4,5, and 6.

If time permits pass out hurricane maps obtained from WJXT-TV Channel 4, Jacksonville, Florida. Keep these maps in the classroom for tracing hurricanes during the hurricane season.

STUDENT E - 9

WEATHER MAP

Materials for groups of three:

1. Overhead transparency marker 2. 3 Clear acetates 3. Map of United States

The forecasting of weather is as old as civilization. The Indians danced to cause it to rain. The earlier civilization named Gods and Goddesses in honor of winds, rains, storms, and the sun and worshiped them. Grandmothers and Grandfathers still claim their "rheumatiz" is a weather predictor; some say they can even "smell" rain and farmers report accurate weather predictions from the way cows behave. Fishermen claim fish bite better during clear calm days while others claim they bite better during stormy weather. Man can predict weather with a measure of accuracy. Weather stations and weather satellites make the weather more predictable. The weather experts, called meteoroligists, give the percent of probability-like the chances are 90% probability of rain.

Since weather predicting is one of the oldest universal "sports" try it out for yourself. This activity will be the first in a series to actually prepare weather forecasts. A daily observation will be required along with recording measurable weather indicators. If you keep score:

60% right - call yourself "Genius"
50% right - call yourself "Brilliant"
40% right - call yourself "Smart"
30% right - call yourself "Hard-luck"
20% right - call yourself "X-O-1"
10% right - call yourself "Sorry"
0% right - call yourself "Stupid"

Your instructor will give each group three clear acetates. Draw a map of the United States on each acetate using a magic marker. Be sure to draw in the state boundries, but do not label the states' names. You are to daily draw in the lows, highs, fronts, and areas of rain. Then by watching the movement of these conditions and locally recorded data, predict the weather conditions. You start predicting weather tomorrow! Yea! Yea!

TEACHER DIRECTION E - 10

## BAROMETRIC PRESSURE

Materials for groups of three:

1. Gas bottle (8 oz.)
2. One-hole stopper
3. Scotch tape
4. Metric ruler
5. Glass tubing (14 inches)
6. String
7. Food dye (any color)
8. Bunsen Burner

Materials for class - Melted parafin in a beaker

Before starting E-10 draw in the fronts, highs, lows, rain, and clear areas on transparency E-10 and instruct the students to draw this information on one of their acetates. The students have three acetates, this will provide a clean acetate daily, then by using their drawings as overlays, they can see the daily movement of national conditions. After three acetates have been used, wash the first acetate to use on the fourth day, etc. This will provide a continuous two day record.

The purpose of this activity is to make a barometer to measure atmospheric pressure. The word barometer comes from the Greek words, "baros" meaning weight or pressure, and meter meaning measure.

Atmospheric pressure varies with altitude, temperature of the air, and the amount of moisture in the air. A "Low Pressure" zone has a low barometric pressure and a "High Pressure" zone has a high barometric reading. Rain is generally associated with the low pressure, whereas a clear day is generally associated with high pressure. A drop in barometric pressure is an indication of rain. Likewise, an rise in barometric indicates clearing or continued clear weather.

Do not explain barometric pressure at this time. Just make a simple water barometer and help the students figure it out. Tell the students you will not tell them

Teacher Direction
Page 2

if they ask. Students can find out from any general science book if they wish to read about it.

DOES THE ATMOSPHERE HAVE WEIGHT? Yes. DOES THE ATMOSPHERE PUSH DOWN ON THE EARTH? Yes. IF SOMETHING PUSHES DOWN, DOES IT CAUSE PRESSURE? Yes. AS WEATHER CHANGES, THE ATMOSPHERIC PRESSURE CHANGES. SCIENTIST MEASURE THIS PRESSURE USING A BAROMETER.

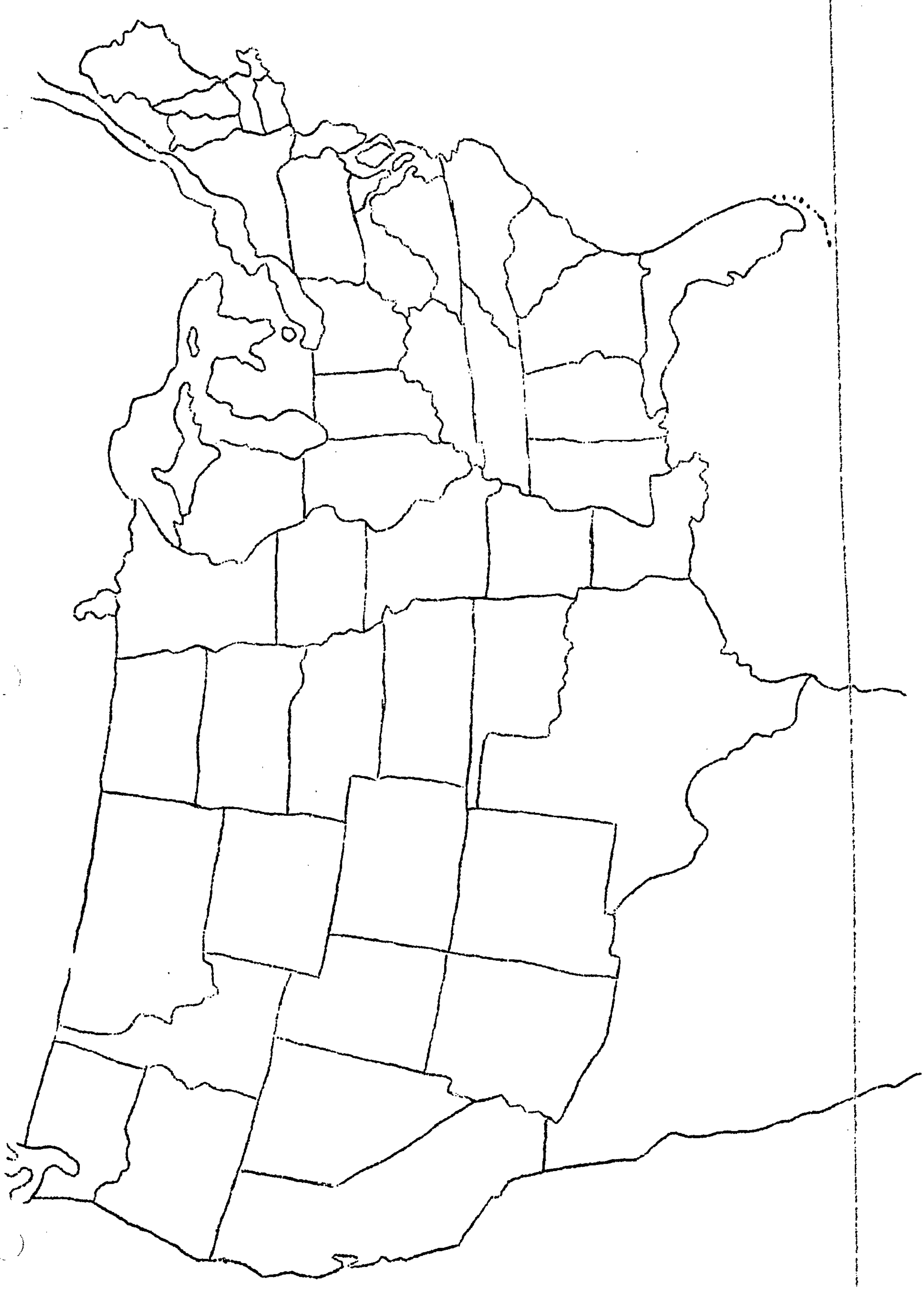
LETS MAKE A BAROMETER AND SEE HOW IT WORKS.

Pass out E-10

Using transparency E-10, discuss the procedures to make the barometer.

Pass out the prepared tables and instruct the students to fill in the correct information. Use transparency E-10-a to insure correct data. Upon completion of the chart, ask the students to predict the weather for the next day using their national weather map as well as any other information they can find.

Ask the students to graph their results daily.



STUDENT

E - 10

## BAROMETRIC PRESSURE

Materials for groups of three:

1. Gas bottle ( 8 oz)
2. One-hole stopper
3. Scotch tape
4. Metric ruler
5. Glass tubing
6. String
7. Food dye

What is a high pressure zone. What is a low pressure zone. How can you tell. There is a way to tell - use a barometer. Everyone in Greece knows what this means - baros means weight or pressure, and meter means measure. So a barometer is a instrument to measure the atmospheric pressure. Let's make one and keep a record of it's readings and try to find out how it effects our weather.

This must be made very carefully and in steps:

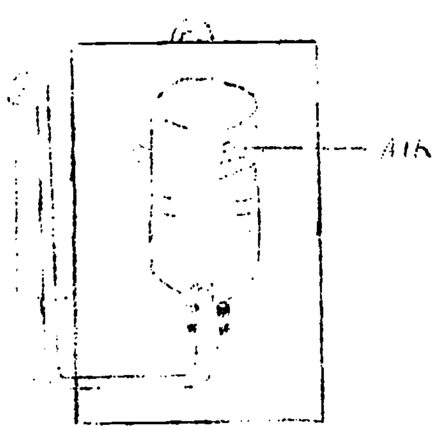
Step 1 - Bend glass tubing as shown in the drawing

Step 2 - Fill gas bottle up to one inch from the top and add food dye for color.

Step 3 - Insert tubing in the one hole stopper. Wet the stopper and tubing with glycerine before putting the tubing in the stopper. Use gloves or a paper towel to protect your hands in case the tubing breaks.

Step 4 - Turn bottle over and seal with paraffin

Step 5 - Tape a metric ruler to the glass tube. The 3 cm line should be at the water level.



Student
page 2

Yea - You have made a barometer. Congratulations. By the way a fellow named Toricelli discovered the principle for making a barometer in 1640. Thanks Mr. Toricelli.

Lets set up our weather observation charts. You are to keep a daily record of the weather and predict the weather for the next day. Do not fill in the tables until instructed to do so.

Student
page 3

WEATHER PREDICTION TABLE AND GRAPH

I DO BELIEVE THE WEATHER - - -

| DAY | Clear or Cloudy | Rain | Barometric Pressure | Temperature | Humidity | Dew Point | Wind Direction | Wind Speed | Prediction will it rain most of tomorrow |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | |
| 2 | | | | | | | | | |
| 3 | | | | | | | | | |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | |
| 6 | | | | | | | | | |
| 7 | | | | | | | | | |
| 8 | | | | | | | | | |
| 9 | | | | | | | | | |
| 10 | | | | | | | | | |
| 11 | | | | | | | | | |
| 12 | | | | | | | | | |

Student
page 4

WEATHER
GRAPH

| DAY | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BAROMETRIC PRESSURE | 4 | | | | | | | | | | | | |
| | $3\frac{1}{2}$ | | | | | | | | | | | | |
| | 3 | | | | | | | | | | | | |
| | $2\frac{1}{2}$ | | | | | | | | | | | | |
| | 2 | | | | | | | | | | | | |
| TEMPERATURE | 90 | | | | | | | | | | | | |
| | 85 | | | | | | | | | | | | |
| | 80 | | | | | | | | | | | | |
| | 75 | | | | | | | | | | | | |
| | 70 | | | | | | | | | | | | |
| | 65 | | | | | | | | | | | | |
| HUMIDITY | 90% | | | | | | | | | | | | |
| | 85% | | | | | | | | | | | | |
| | 80% | | | | | | | | | | | | |
| | 75% | | | | | | | | | | | | |
| | 70% | | | | | | | | | | | | |
| | 65% | | | | | | | | | | | | |
| | 60% | | | | | | | | | | | | |
| | 55% | | | | | | | | | | | | |
| WIND | NE | | | | | | | | | | | | |
| | N | | | | | | | | | | | | |
| | NW | | | | | | | | | | | | |
| | W | | | | | | | | | | | | |
| | SW | | | | | | | | | | | | |
| | S | | | | | | | | | | | | |
| | SE | | | | | | | | | | | | |
| | E | | | | | | | | | | | | |
| DEW POINT | 75 | | | | | | | | | | | | |
| | 70 | | | | | | | | | | | | |
| | 65 | | | | | | | | | | | | |
| | 60 | | | | | | | | | | | | |
| | 55 | | | | | | | | | | | | |
| | 50 | | | | | | | | | | | | |
| | 45 | | | | | | | | | | | | |

WEATHER
PREDICTOR

TEACHER DIRECTION E - 11

HUMIDITY

Materials for groups of three:

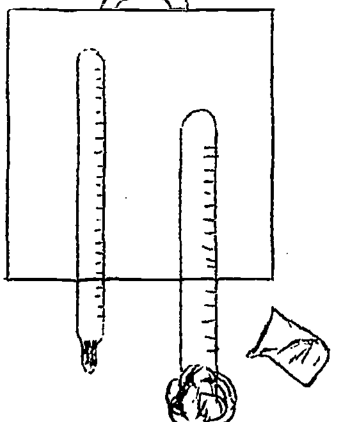
1. 2 Thermometers
2. Cotton ball
3. Rubber band
4. Humidity Table
5. Cardboard 6" x 4"
6. Beaker of water

The prupose of this activity is to develop skills in determining relative humidity.

Allow the students to fill in the national map and read the barometric pressure and temperature. These readings will provide information for the Weather Prediction Table and will need to be taken daily. One student reads the barometer, another determines the temperature, and the third student records and graphs the information.

Relative humidity is the amount of water vapor in the air compared to the amount it can hold at that temperature. If the air has only half the moisture it can hold at a temperature the relative humidity is 50%. This has an effect on comfort - high humidity is uncomfortable.

WHAT IS THE DIFFERENCE IN DESERT AIR AND FLORIDA AIR? Desert air is dry. Florida air is wet or humid. WHO KNOWS WHAT HUMIDITY IS? The amount of water in the air. LETS DETERMINE HUMIDITY. Use transparency E-11 to demonstrate. Pass out #-11. The students need to go outside to perform the activity. Three readings are needed, then an average recorded. Let the students practice in the room before going outside.



Teacher Direction
Page 2

The cardboard and thermometers are to be waved back and forth for 3 minutes, then record the temperatures. The cotton must have the same amount of water each time, so instruct the students to saturate it by pouring water on the cotton. Caution the students not to strike the thermometers hard, this will ruin them.

Read the Activity with the students and have one practice activity.

Upon completion of the activity determine the relative humidity in a class discussion. Discuss the findings and fill in transparency E-11-a of the table.

STUDENT

E - 11

HUMIDITY

Materials for groups of three:

1. 2 Thermometers
2. Cotton ball
3. Rubber band
4. Humidity table
5. Cardboard 10" x 3"
6. Beaker of water

One boy said to one girl one day, "It sure is a humid day." Two days later one boy said to two girls "It sure is a humid day." One girl said to the boy, "What do you mean?" Well what is the relative humidity? That is how much water is in the air compared to how much it would hold. For instance, 50% relative humidity means that the air has absorbed 50% of the water that it can hold. 100% humidity means the air can not hold any more water.

Actually relative humidity tells us a lot. Remember the air absorbs water that evaporates from the Earth. The relative humidity tells us how much water the air can hold compared to its total capacity at its temperature.

The humidity we will measure today and in the future will be for the temperature at the time the temperature readings are taken.

Two thermometers are required to determine the relative humidity. One thermometer is called a "dry bulb thermometer." The second thermometer is called a "wet bulb thermometer." The wet bulb is called wet because it has a wet cotton ball attached by a rubber band.

Student
page 2

To construct your hygrometer:

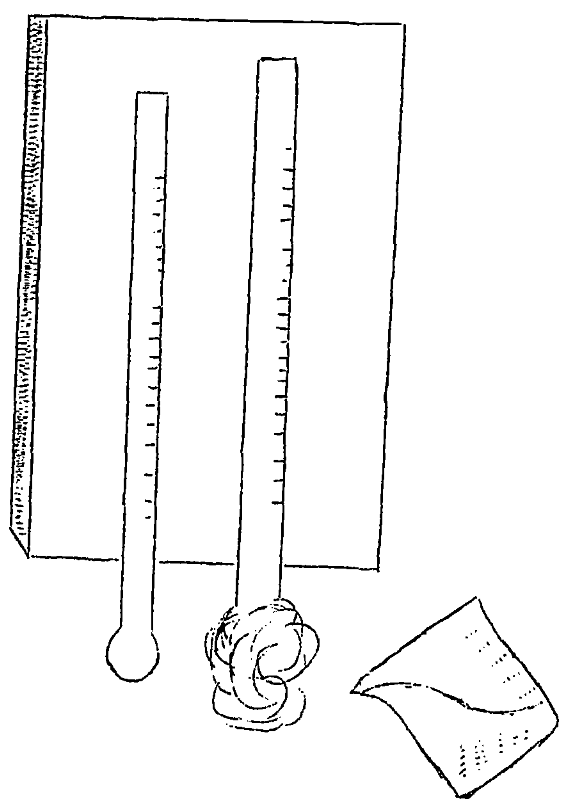
First - attach two thermometers to a piece of cardboard with tape.

Second - put a cotton ball on the end of a thermometer using a rubber band. This is the wet bulb.

Third - pour water on the cotton slowly until it drips one drop of water.

Fourth - slowly fan the area near your knees with the thermometers for about three minutes, then record the temperature.

Repeat this three times in three different places.



Student
Page 3

To use the tabel, locate the dry bulb reading in the left hand column. Now move across the column till you come to the top figure showing, the difference between wet and dry thermometers.

HUMIDITY TABLE

Difference Between Dry and Wet Bulb Readings

| DRY | 1° | 2° | 3° | 4° | 5° | 6° | 7° | 8° | 9° | 10° | 11° | 12° | 13° | 14° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100 | 96 | 93 | 89 | 86 | 83 | 80 | 77 | 73 | 70 | 68 | 65 | 62 | 59 | 56 |
| 98 | 96 | 93 | 89 | 86 | 83 | 79 | 76 | 73 | 70 | 67 | 64 | 61 | 58 | 56 |
| 96 | 96 | 93 | 89 | 86 | 82 | 79 | 76 | 73 | 69 | 66 | 63 | 61 | 58 | 55 |
| 94 | 96 | 93 | 89 | 85 | 82 | 79 | 75 | 72 | 69 | 66 | 63 | 60 | 57 | 54 |
| 92 | 96 | 92 | 89 | 85 | 82 | 78 | 75 | 72 | 68 | 65 | 62 | 59 | 56 | 53 |
| 90 | 96 | 92 | 89 | 85 | 81 | 78 | 74 | 71 | 68 | 65 | 61 | 58 | 55 | 52 |
| 88 | 96 | 92 | 88 | 85 | 81 | 77 | 74 | 70 | 67 | 64 | 61 | 57 | 54 | 51 |
| 86 | 96 | 92 | 88 | 84 | 81 | 77 | 73 | 70 | 66 | 63 | 60 | 57 | 53 | 50 |
| 84 | 96 | 92 | 88 | 84 | 80 | 76 | 73 | 69 | 66 | 62 | 59 | 56 | 52 | 49 |
| 82 | 96 | 92 | 88 | 84 | 80 | 76 | 72 | 69 | 65 | 61 | 58 | 55 | 51 | 48 |
| 80 | 96 | 91 | 87 | 83 | 79 | 75 | 72 | 68 | 64 | 61 | 57 | 54 | 50 | 47 |
| 78 | 96 | 91 | 87 | 83 | 79 | 75 | 71 | 67 | 63 | 60 | 56 | 53 | 49 | 46 |
| 76 | 96 | 91 | 87 | 82 | 78 | 74 | 70 | 66 | 62 | 59 | 55 | 51 | 48 | 44 |
| 74 | 95 | 91 | 86 | 82 | 78 | 74 | 69 | 65 | 61 | 58 | 54 | 50 | 47 | 43 |
| 72 | 95 | 91 | 86 | 82 | 77 | 73 | 69 | 65 | 61 | 57 | 53 | 49 | 45 | 42 |
| 70 | 95 | 90 | 86 | 81 | 77 | 72 | 68 | 64 | 59 | 55 | 51 | 48 | 44 | 40 |
| 68 | 95 | 90 | 85 | 80 | 76 | 71 | 67 | 62 | 58 | 54 | 50 | 46 | 42 | 38 |
| 66 | 95 | 90 | 85 | 80 | 75 | 71 | 66 | 61 | 57 | 53 | 48 | 44 | 40 | 36 |
| 64 | 95 | 90 | 84 | 79 | 74 | 70 | 65 | 60 | 56 | 51 | 47 | 43 | 38 | 34 |
| 62 | 94 | 89 | 84 | 79 | 74 | 69 | 64 | 59 | 54 | 50 | 45 | 41 | 36 | 32 |
| 60 | 94 | 89 | 83 | 78 | 73 | 68 | 63 | 58 | 53 | 48 | 43 | 39 | 34 | 30 |
| 58 | 94 | 88 | 83 | 77 | 72 | 66 | 61 | 56 | 51 | 46 | 41 | 37 | 32 | 27 |
| 56 | 94 | 88 | 82 | 76 | 71 | 65 | 60 | 55 | 50 | 44 | 39 | 34 | 30 | 25 |
| 54 | 94 | 88 | 82 | 76 | 70 | 64 | 59 | 53 | 48 | 42 | 37 | 32 | 27 | 22 |
| 52 | 94 | 87 | 81 | 75 | 69 | 63 | 57 | 51 | 46 | 40 | 35 | 29 | 24 | 19 |
| 50 | 93 | 87 | 80 | 74 | 67 | 61 | 55 | 49 | 43 | 38 | 32 | 27 | 21 | 16 |
| 48 | 93 | 86 | 79 | 73 | 66 | 60 | 54 | 47 | 41 | 35 | 29 | 23 | 18 | 12 |
| 46 | 93 | 86 | 79 | 72 | 65 | 58 | 52 | 45 | 39 | 32 | 26 | 20 | 14 | 8 |
| 44 | 93 | 85 | 78 | 71 | 63 | 56 | 49 | 44 | 36 | 30 | 23 | 16 | 10 | 4 |
| 42 | 92 | 85 | 77 | 69 | 62 | 55 | 47 | 40 | 33 | 26 | 19 | 12 | 5 | 0 |
| 40 | 92 | 83 | 75 | 68 | 60 | 52 | 45 | 37 | 29 | 22 | 15 | 7 | 0 | 0 |

The figure where the two columns cross, shows the per centage of relative humidity.

TEACHER DIRECTION

E - 12
WIND

Materials for groups of three:

1. Cardboard (6" x 8")
2. Plastic straw
3. String (30")
4. Lead weight (1 1/2 oz.)
5. Protractor
6. Compass

This activity is designed to show wind movement - speed and direction. It is difficult to determine wind speed and direction accurately but the procedure described in this activity will provide sufficiently accurate results for our purposes. By measuring the amount of deflection caused by the wind on a paddle wind speed can be determined. This will require some type of calibration with known wind speeds, such as from weather reports.

HOW DO WE KNOW WHEN THE WIND IS BLOWING? Feel it, see clouds move, see trees move, see dust being blown, the angle which rain falls. WHAT EFFECT DOES THE WIND HAVE ON WEATHER? Cause temperature change, rate of evaporation. HOW HARD IS THE WIND BLOWING NOW? Cannot tell in the classroom. DOES THE WIND BLOW THE SAME SPEED CLOSE TO THE GROUND AS IT DOES TEN FEET ABOVE THE GROUND? No. Wind speed is constantly changing and is affected by local objects. LETS MEASURE THE WIND SPEED AND DETERMINE THE DIRECTION IT IS BLOWING.

The students are to cut a cardboard box into 6"x8" rectangles. The thickness of the sides of the box is needed to provide the strength required. Each group of students is to make an anemometer and will need one piece of cardboard. Instruct the students to watch you construct one using transparency E-12, then pass out the activity sheet.

Holding the card so that the plumb bob string covers the line on the back and facing the wind - the position of greatest deflection - read the degrees deflection. Compare this with a miles per hour chart you make from weather reports for wind speed.

The compass will tell you the wind direction. Explain how to use it using transparency E-12-a.

STUDENT E - 12

WIND

Materials for groups of three:

1. Cardboard (6" x 8")
2. Plastic straw
3. String (30")
4. Lead Weight ($1\frac{1}{2}$ oz)
5. Protractor
6. Compass, magnetic

Wind blows causing tree limbs to bend, dirt to fly, and waves to form in lakes and oceans. The speed the wind blows tells how much force is exerted by the wind. Wind speed is usually measured in miles per hour the same as the speed of an automobile is measured. Today you will measure wind by degrees, or how much it will cause a straw to move. The wind blows at different speeds at different places, so an average wind speed will need to be figured.

Follow the directions on the next page in assembling your wind guage.

NEXT PAGE

Now to determine the wind speed. One student is to hold the cardboard and make sure the plumb bob lines up with the vertical line. The second student turns the board around until the greatest deflection is measured - remember the number of degrees. The third student holding the compass notes the wind direction.

Measure the wind outside at three different locations away from buildings (20ft)

WIND DIRECTION____________________

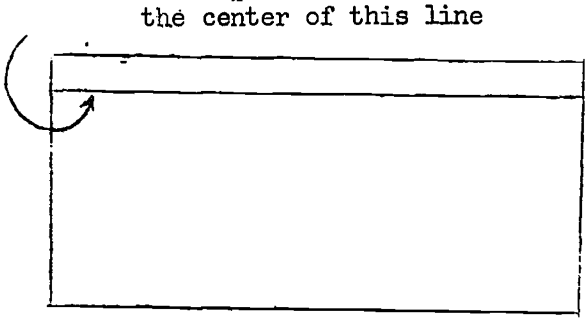
1. Degree of deflection____________________
2. Degree of deflection____________________
3. Degree of deflection____________________

TOTAL____________________

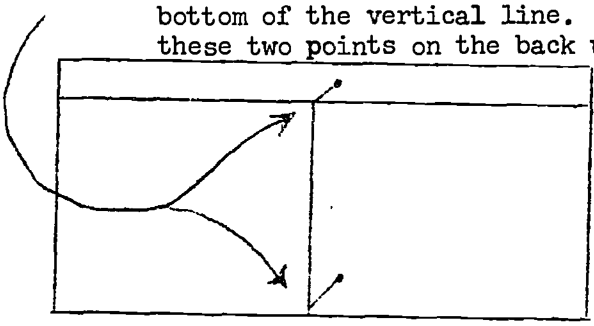
AVERAGE____________________

Record the average in the weather prediction chart

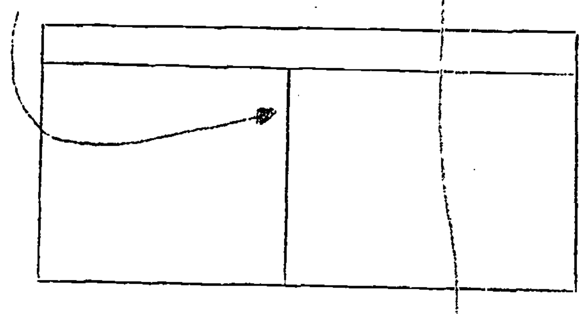
1. Draw a line across the top of the board $\frac{1}{2}$ inch from the top and locate the center of this line



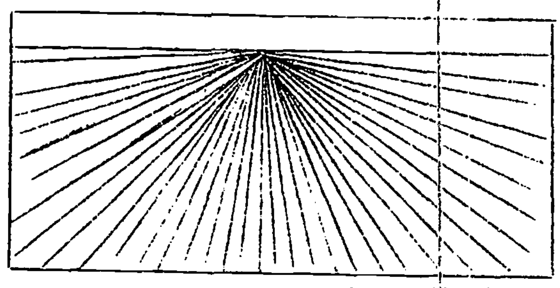
2. Stick a pin through the board at the intersection of the lines and near the bottom of the vertical line. Connect these two points on the back with a line



3. Using the protractor, draw a line perpendicular ($90^{\circ}$) to the one across the top at the center point.

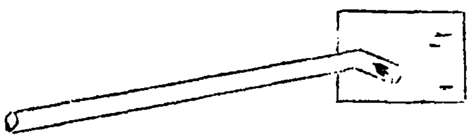


4. Using the protractor, draw in lines every $5^{\circ}$ lining up with $90^{\circ}$ line.

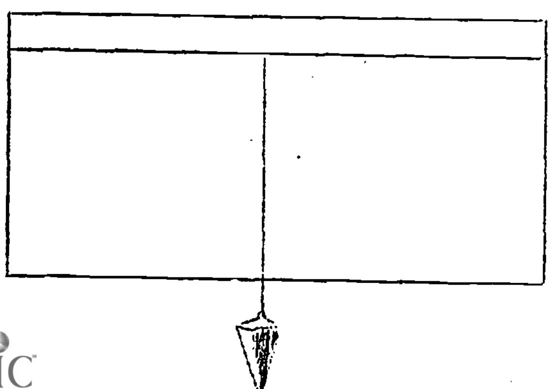


This completes the drawing on the board. Now to make the deflector

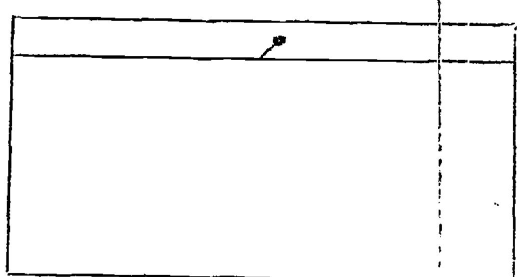
1. Cut out a 1" x 2" deflector from an index card and staple it onto the straw.



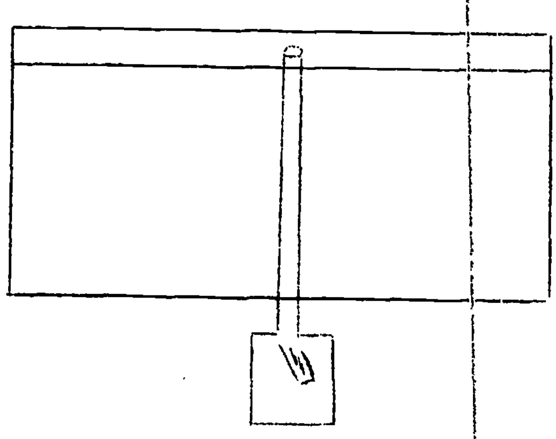
2. Make a plumb bob by attaching a string to the lead weight and the other end to the pin near the head.



3. Push the pins through the cardboard from the back at the intersection of lines.



4. Push the end of the straw on to the pin with the deflector hanging down.



E - 13

Teacher Direction

## DEW POINT

Materials for groups of three:

1. Beaker (400 ml)
2. Thermometer
3. Ice

The purpose of this activity is to demonstrate that cooling the air causes water to form drops in the form of dew.

The students are to slowly cool a beaker of water by adding small quantities of ice. As the water and beaker cools, the air around the beaker will cool, the relative humidity will reach 100%, and drops of water will form on the beaker. The same thing happens at night when there is no wind. The air cools and condensation forms on the grass or ground. If enough cooling occurs fog will form. If the condensation freezes it is called frost.

The students can easily see the water form on the outside of the beaker, but it will not be easy for them to understand the cooling of the surrounding air. It is suggested the students have a practice run in the class, then go outside in the wind to see the difference. (If the humidity is high, expect poor results.)

LETS MAKE RAIN. WHO KNOWS HOW TO MAKE RAIN? Discussion.Stress cooling air. LETS COOL AIR AND MAKE IT RAIN.

Using transparency E-13 demonstrate the activity. Then tell the students this is called the dew point - the temperature at which drops of water appear on the outside of a container. Caution the students not to use too much ice.

Upon completion of the activity discuss the results in a class discussion using transparency E-13-a of the table. Have the students fill in the data in the Weather Prediction Table and Graph.

| TEMPERATURE | INSIDE | | | | OUTSIDE | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | Avg. | 1 | 2 | 3 | Avg. |
| Water appears on the beaker | | | | | | | | |

STUDENT

E - 13

DEW POINT

Materials for groups of three:

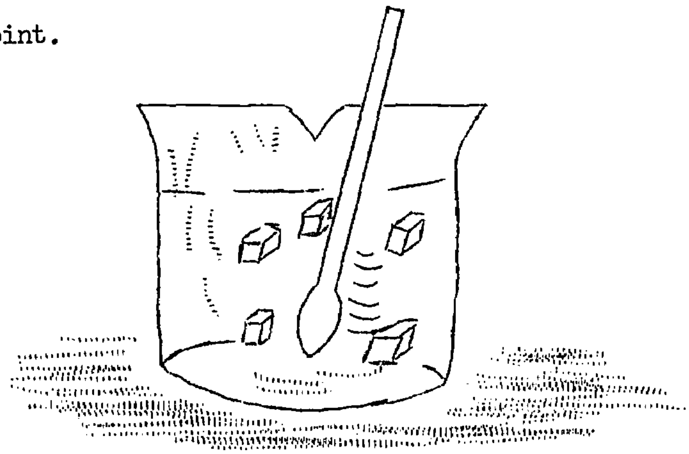
1. Beaker (400 ml) 2. Thermometer 3. Ice

The dew point is the temperature at which vapor in the air condenses to form drops of water. The relative humidity tells us how much water is in the air compared with how much it will hold. The relative humidity at the dew point is 100%. It is raining because drops of water are coming out of the air.

So! Lets have rain inside. Put on your raincoat!

To a beaker of water add a little ice and stir slowly. Add ice as needed to slowly cool the water, but only a little at a time. WATCH for a drop of water to form on the outside.

The INSTANT you see a drop form - Read the temperature of the water. This is the dew point.



| | PRACTICE | INSIDE | | | OUTSIDE | | |
|---|---|---|---|---|---|---|---|
| TEMP. WHEN A DROP OF WATER APPEARS ON THE BEAKER | | | | | | | |
| TOTALS OF 1 2 & 3 | | | | | | | |
| AVERAGE | | | | | | | |

Student
page 2

What happened? The cold beaker cooled the air surrounding the beaker. The colder temperature cooled the air to where the relative humidity reaches 100%. Then the water vapor condenses on the beaker as dew. If it condenses on dust particles in the air it would be named fog or clouds.

Several important things are demonstrated. At night the air cools above the ground or grass and when the temperature reaches the dew point -- dew appears and the grass is wet. If a large mass of air cools to the dew point fog appears.

Windy nights generally prevent fog and dew. This is due to mixing the warm and cold air thus preventing the temperature from reaching the due point.

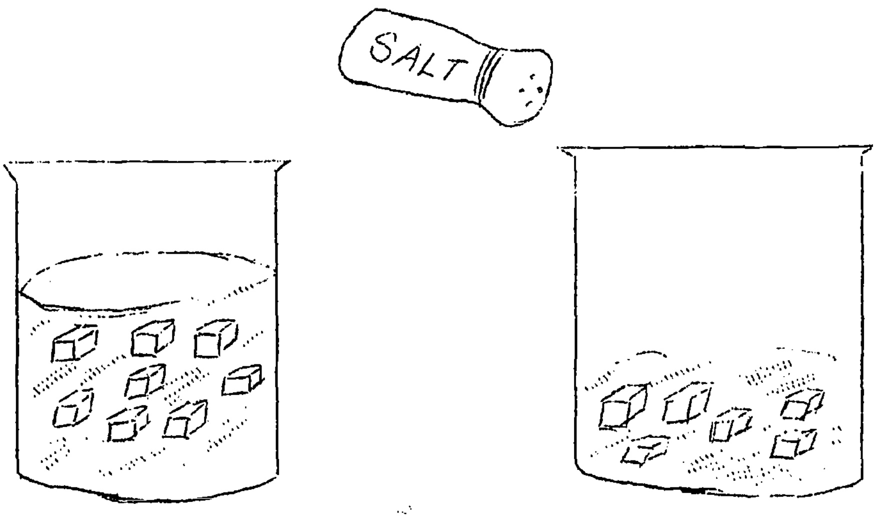
Record your data in the Weather Prediction Table and Graph. You should be getting much better at predicting weather.

TEACHER RESOURCE E - 14

INVESTIGATING FROST

Frost is not frozen dew; frost is frozen water vapor. Frost forms on cold objects when moist air comes in contact with these cold objects. Frost forms in the same way dew forms, but the temperature must be below 0' or 32' F for frost to form. Frost consists of crystals of ice that form directly from the water vapor of the air.

In Student Activity E-14 the students cool the beaker by adding salt to the crushed ice. Adding the salt to the ice lowers the melting point of the mixture in the beaker. As the ice melts the temperature drops to the melting point of the mixture of salt and water. It takes energy to melt the ice. The heat energy in the beaker is used in melting the ice and as a result the temperature of the beaker cools below the freezing point of pure water. The temperature of the beaker can be cooled below 32 degrees F in this way.




Under these conditions water vapor in the air should come out of the air, (sublimates) as ice crystals (frost) on the walls of the beakers. Frost forms in this way on automobiles during freezing nights. Similarly frost forms on the cooling unit in a refrigerator.

TEACHER DIRECTION

E - 14

INVESTIGATING FROST

Materials for groups of three:

1. Beaker (400 ml)
2. Thermometer
3. Ice
4. Table salt
5. Paper towels (2)
6. Stirring Rod

Each group is to make frost. While one student is making the beaker cold by adding salt to the crushed ice and stirring, another is to take the temperature and a third is to remove the dew from the outside of the beaker until frost begins to form. They are to note that frost does not form until the temperature is lowered below the freezing point of water. In this way they will see that frost is formed in the same way as dew, but that dew forms on cold objects when the temperature of the cold object is above freezing point of water, and that frost forms when the temperature is below the freezing point of water.

Have the materials ready for the groups to get as they start their activity. Pass out E-14. Place transparency E-14 on the overhead projector. Read the first 3 paragraphs of E-14 with your students. Then discuss with them the procedures to follow using it.

GET THE MATERIALS NEEDED FOR THE ACTIVITY AS SHOWN IN THE DIAGRAM. DO NOT ADD ANY SALT TO THE BEAKER UNTIL YOUR GROUP IS READY TO DO THEIR PART. ONE PERSON IS TO ADD SALT AND STIR, ANOTHER IS TO WATCH THE TEMPERATURE, AND ANOTHER IS TO KEEP THE DEW WIPED OFF THE OUTSIDE OF THE BEAKER. THE MELTING OF THE ICE WILL COOL THE BEAKER. FIND OUT AT WHAT TEMPERATURE THAT FROST BEGINS TO FORM ON THE BEAKER. WHY? Discussion. WHY DO YOU KEEP WIPING THE BEAKER? Discussion. To show that frost is not frozen dew. WHY DO YOU ADD SALT TO THE ICE? Discussion. To cool the beaker. LET'S MAKE SOME FROST.

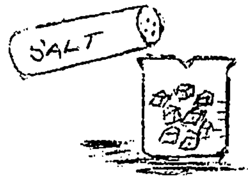
STUDENT

E - 14

INVESTIGATING FROST

Materials for groups of three:

1. Beaker (400 ml)
2. Thermometer
3. Ice (200 ml)
4. Table salt
5. Paper towels (2)
6. Stirring rod




You will recall that dew forms on cold objects when the air is warm and moist by condensing the water vapor in the air when it is chilled to the dew point. You made dew on the outside of a glass of water.

Now we want to find out what frost is and how it is formed. You have seen frost on the window pane of your house on cold mornings. But most of you have seen frost in other places, too. Haven't you seen the flakes of ice around the cooling unit in your refrigerator, or in the deep freeze units in a supermarket? These flakes of ice are really frost; they are formed exactly as frost is formed outside. These fluffy frost flakes are quite different than the ice cubes formed by the freezing of liquid water. Maybe they are formed when water vapor in the air is frozen quickly. The purpose of this activity is to see if frost is frozen water vapor - not frozen dew; and to answer the question. How is frost formed?

If frost is frozen water vapor which forms on very cold solid objects, then we could make some frost on the outside of a beaker if we could cool it way below the freezing point of water. We can make the outside of a beaker very cold by filling it with crushed ice and then adding several teaspoons of salt to the beaker. To be sure that frost is not frozen dew, we must keep wiping the dew off the outside of the beaker until the temperature is cooled below the freezing point (32'F or 0'C).

Student
page 2

Assemble your apparatus as shown in the diagram. Fill the beaker with ice, add several teaspoons of salt and stir.

While one person keeps stirring the mixture of ice and salt, another keeps observing and noting the temperature, and the third person keeps wiping the dew from the outside of the beaker. Note and record the temperature at which frost begins to form on the outside of the beaker.

At what temperature did frost begin to form on the outside of the beaker?_____

Did dew form on the outside of the beaker before the beaker cooled to the freezing point? __________ Was the dew point above or below the freezing point?

________________

Where does the frost come from?________________________________________

How is frost formed?________________________________________________

____________________________________________________________________

Topic 2 - The formation of clouds requires a decrease in temperature, or pressure, and dust particles.

E - 15

MAKING A CLOUD

The conditions required for making a cloud are similar to those required for the formation of dew or frost. There must be moist air, there must be particles (dust, smoke etc.) in the air for the tiny droplets of water to condense on, and the temperature of the air must be cooled below the dew point. The students will not know that when you increase the pressure of gas, you warm the gas, and that when you decrease the pressure of a gas the temperature drops. Some of them will know, however, that as you let air out of an overinflated bicycle tire, that the air feels cool. They may also know that if they use a bicycle pump to inflate a bicycle tire, that the tube of the pump becomes warm, It becomes warm from the increased pressure on the air being forced into the tire. Some may know that in a Diesel engine there are not spark plugs, that the fuel is ignited by the increased temperature produced by compressing of the gas in the cylinders.

They must cool the gas in the bottle by expansion (decreased pressure). Any other method of cooling causes water to condense as dew on the inside of the bottle. The students need to have the cloud form on the particles in the bottle - not to have dew form on the inside of the bottle.

TEACHER DIRECTIC N E - 15

MAKING A CLOUD

Materials for groups of three:

1. Glass bottle or jug (lqt. to 1 gal.)
2. Water 250 ml
3. Box of matches
4. Small amount alcohol on cotton

Tell the students that they are going to make a cloud in a bottle. Show transparency E-15 on the over head projector. Tell them that they will be making a cloud as shown on the transparency.

Pass out E-15.

Read the first two paragraphs of the Students E-15 with the students. Then discuss the procedures with them.

GET THE MATERIALS FOR YOUR GROUP TO DO THE ACTIVITY AS SHOWN IN THE DIAGRAM. FIRST PUT A LITTLE WATER IN THE BOTTLE, SHAKE THE BOTTLE, AND THEN POUR OUT THE EXCESS WATER. WHY? Discussion. To make the air in the bottle moist. WHILE ONE HOLDS THE BOTTLE UPSIDE DOWN, ANOTHER MEMBER OF YOUR GROUP WILL HOLD A BURNING MATCH UNDER THE NECK OF THE BOTTLE? WHY? Discussion. To get dust in the bottle. THEN THE THIRD MEMBER OF YOUR GROUP WILL BLOW HARD IN THE BOTTLE WITH HIS LIPS PRESSED HARD AGAINST THE BOTTLE. WHY? To increase the pressure in the bottle, which will warm the air in the bottle, which will mean that more water evaporates into the air in the bottle. THEN HE LETS THE AIR OUT OF THE BOTTLE SUDDENLY. WHY? To cool the air in the bottle by lowering the pressure in the bottle. A CLOUD FORMS IN THE BOTTLE. THE CONDITIONS REQUIRED FOR A CLOUD TO FORM IN THE BOTTLE ARE (1) THE BOTTLE HAS WARM MOIST AIR IN IT, (2) DUST IS ADDED AS SMOKE AND (3) THE AIR IN THE BOTTLE IS COOLED.

Teacher Direction
Page 2

WHY DO YOU WIPE THE MOUTH OF THE BOTTLE WITH COTTON WET IN ALCOHOL BEFORE LETTING ANOTHER PERSON BLOW IN THE BOTTLE? Discussion. To keep from spreading germs from one person to another.

Have the students perform their experiment. While they are making a cloud in their bottle, circulate among them and answer their questions. After they have completed the answers to the questions on the activity sheet, have them put their materials in the place you have designated.

STUDENT E - 15

MAKING A CLOUD

Materials for groups of three:

1. Glass bottle or jug (1 qt. to 1 gal)
2. Water 250 ml.
3. Box of matches
4. Small amount alcohol on cotton.

You have made dew, and you have made frost. Have you ever made a cloud? I doubt that you have, but you can make one in a bottle if you simulate the conditions under which clouds form in nature. What was the source of the dew and the frost? Water vapor in the air wasn't it? What do you suppose the source of a cloud is? Could it also be water vapor in the air. Yes, it might be. Let's assume it is. To make dew or frost, what did you do to the objects on which it formed? You cooled it, didn't you. Well clouds form up in the air, not on large cold objects. Perhaps they form on dust particles in the air when the air is chilled. If this is the case, then we should be able to make a cloud in a bottle.

If we can make the air in the bottle warm, moist, dusty and then cool it we should be able to make a cloud in the bottle. We can make the air moist by putting a little water in it, shaking it, and then pouring out the excess water. We can make the air dusty by holding the bottle inverted over a burning match. The smoke from the match makes it dusty. We can warm the air by pressing the bottle mouth tightly against our lips and blowing into it as we would in inflating a rubber balloon. As we increase the pressure the temperature rises. Then we can cool it by suddenly letting the air out of the bottle. As the pressure in the bottle decreases, the temperature will lower. We should warm the bottle of air by blowing into it, and then cool it by letting the air out suddenly.

First, put a little water in the bottle, shake the bottle, and then pour out the excess water. While one holds the bottle upside down, another should hold a burning match under the open mouth of the bottle so that smoke goes up into the bottle. Then the third member of your group should first warm the air by blowing into it as

Student
page 2

hard as he can and hold it a short while. Then, as the others watch, he should suddenly let the air out which cools the air inside the bottle. Do this several times. After one has done this several times, wipe off the mouth of the bottle with cotton soaked in alcohol, and have another member of the group make the cloud. Then wipe off the mouth again and have the third member of your group make the cloud.

Where did the water of the cloud come from?________________________

Why did you hold the bottle over the flame of a match?________________

__________________________________________________________

Did more moisture evaporate into the air in the bottle as you increased the pressure in the bottle?__________________________________

Why did you suddenly let the air come out of the bottle?_______________

__________________________________________________________

What must be the condition of the air if clouds are to form?

Dry or moist?__________________________

Dust in the air or no dust in the air?________________________

What must happen to the temperature of the air if clouds are to form?

__________________________________________________________

In this activity we cooled the air in the bottle by ________________________

__________________________________________________________

Topic 3 - Air is composed mostly of gases, but it also contains water and dust. Air occupies space, has weight and exerts pressure. It acts as a giant heat engine in bringing us our daily water.

WE LIVE AT THE BOTTOM OF THE VAST OCEAN OF AIR. WE CANNOT SEE THIS AIR BUT WE CAN FEEL IT, AND AT TIMES ON A WINDY DAY, WE CAN HEAR IT. THIS AIR IS IMPORTANT TO US FOR MANY REASONS. CAN YOU NAME SOME OF THEM? List on the overhead projector all answers.

WHAT DOES THIS AIR CONTAIN THAT MAKES IT SO VALUABLE TO US? Discussion. List all responses on an acetate. List oxygen if it is not suggested. HOW LONG DO YOU THINK YOU COULD LIVE WITHOUT OXYGEN? Discussion. Short period. WELL, HOW LONG CAN YOU HOLD YOUR BREATH? YOU COULD LIVE ONLY MINUTES LONGER THAN THAT. Disuussion. ABOUT 1/5 OF THE AIR YOU BREATH IS OXYGEN: THE REST IS MOSTLY NITROGEN. TAKE A DEEP BREATH. Pause. MOST OF THAT BREATH WAS NITROGEN. THE REST THE REST OF IT WAS MOSTLY OXYGEN.

OXYGEN AND NITROGEN ARE GASES WHICH COMPOSE ABOUT 99% OF OUR ATMOSPHERE.

WE USUALLY THINK OF THE AIR AS BEING A GAS, BUT IT ALSO CONTAINS SOLID MATERIAL AND LIQUID MATERIALS. YOU KNOW THAT MATERIALS CAN EXIST IN 3 FORMS - SOLIDS, LIQUIDS AND GASES. YOU MAY NOT HAVE KNOWN, HOWEVER, THAT OUR AIR CONTAINS ALL 3 OF THESE. WHERE CAN WE FIND A LIQUID EXISTING IN THE AIR? Explain that water vapor is a gas and not a liquid. CLOUDS CONTAIN TINY DROPS OF WATER - THAT SOMETIMES FALL TO THE EARTH AS RAIN.

HOW ABOUT SOLIDS? CAN YOU FIND ANY TRACES OF SOLID PARTICLES IN THE AIR? List responses on projector. DUST, ASHES, ETC. ARE SOLIDS. WHERE DO THEY COME FROM? HOW DO THEY GET THERE? WOULD YOU BELIEVE THAT MOST OF THE DUST ON OUR TABLE COMES FROM THE AIR? Discussion. HAVE YOU EVER WONDERED HOW IT GOT THERE? Discussion. WHILE WE ARE ON THE SUBJECT, HOW ABOUT POLLUTION?

WOULD IT CONSIST OF GASES, LIQUIDS, OR SOLIDS. WE KNOW WHERE AIR POLLUTION COMES FROM - US. LARGE INDUSTRIES PUT MILLIONS OF POUNDS OF POISONOUS PARTICLES IN THE AIR EVERY DAY. HOW ELSE DO POLLUTANTS GET IN THE AIR? Discussion. EVERY TIME ONE OF YOUR FRIENDS CRANKS UP HIS HONDA HE HELPS TO POLLUTE THE ATMOSPHERE. THINK OF ALL THE CARS AND INDUSTRIES THAT ARE POLLUTING THE AIR YOU BREATHE. WHERE DOES ALL OF THIS POLLUTION GO? Discussion. WHY IS IT WORSE ON MOIST WARM DAYS THAN ON COOL WINDY DAYS? THE AIR MAY BE CONSIDERED AN EXTENSION OF THE EARTH BECAUSE IT CONTAINS MATERIALS FOUND ON AND IN THE EARTH. WE SHALL DO SEVERAL EXPERIMENTS TO FIND WHAT WE CAN ABOUT THE ATMOSPHERE AND THE MATERIALS FOUND IN IT.

SINCE WE ARE PRIMARILY CONCERNED WITH HOW THE AIR BRINGS US OUR WEATHER WE SHALL FIRST INVESTIGATE SOME OF ITS PROPERTIES. DOES IT OCCUPY SPACE? DOES IT HAVE WEIGHT? DOES IT EXERT PRESSURE?

TEACHER RESOURCE

The physical make up of the air is quite complex. Basically speaking however, we can assume that it is an extension of the earth and therefore contains many of the same components. Most students in the class will not even consider the air as matter in the strict sense of the word. Therefore they will not believe the air takes up space and has weight. Before we can get them to think of materials as existing in the air, we must change their concept of air as being 'nothing.' They should begin to think of air as being a space 'fluid' in which birds 'swim' and most other objects 'sink' because of their weight to volume ration.

TEACHER DIRECTION E - 16

INVESTIGATING AIR

Materials for groups of three:

1. Meter stick balance
2. Empty gal. can with rubber stopper, tube and clamp
3. Sand to use as a weight
4. Hand air pump

Demonstrate to the students that air occupies space by pushing an inverted bottle down into a beaker of water. Note that the water does not come up into the bottle. A cork floating on the water beneath the bottle will show this. The bottle is full of air and it keeps the water out.

Develop the idea that air exerts pressure by discussing that when you blow air into a balloon, the air inside the balloon pushes out the sides of the balloon inflating it.

WE ARE GOING TO TRY TO FIND OUT IF AIR HAS WEIGHT. IF IT HAS WEIGHT WE SHOULD BE ABLE TO WEIGH IT, SHOULDN'T WE? DO YOU THINK IT HAS WEIGHT? Yes. Discussion. WHY? Discussion. List all responses on the overhead projector. Pass out E-16.

After the experiments have been completed and the questions answered, the students should reassemble as a class and the results should be discussed.

HOW DID YOUR EXPERIMENT WORK? Discussion. HOW MUCH DO YOU THINK ALL THE AIR IN THE WORLD WOULD WEIGH IF IT WERE POSSIBLE TO WEIGHT IT? Discussion. TWELVE CUBIC FT. OF AIR AT THE EARTHS SURFACE WEIGHS ABOUT A POUND. LETS CALCULATE THE WEIGHT OF THE AIR IN A TYPICAL SCHOOL ROOM APP. 32'x25' = 800 sq.ft., 800 x 12' - 9600 cubic feet. Since it takes 12 cubic feet to weight a pound, the weight of the air in this room is about 9600/12 - 800 pounds.

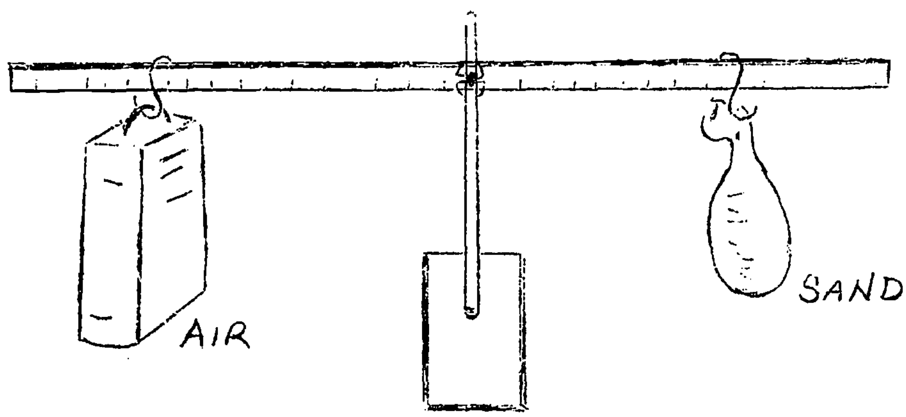
STUDENT

E - 16

INVESTIGATING AIR

Materials for groups of three:

1. Meter stick
2. Empty gal. can with rubber stopper, tube and clamp
3. Ring & Ringstand
4. Sand to use as a weight
5. A hand air pump
6. Condenser clamp




Suspend an empty gallon can on the meter stick balance and balance it carefully by adding sand to the can suspended at the other end of the balance. Remove the empty can from the balance, pump air into it, close the clamp and again suspend the can on the balance. Does the can of air weigh more now than it did before you pumped air into it? How do you account for the change?

What do you think would happen if you would let the air which you pumped into the can out by opening the clamp? Do you think the scale would balance again? Try and see. Does air have weight?______________________________

How do you know?____________________________________

The air extends upwards for several miles above the earth's surface. How do you suppose that this weight of air up above the surface of the earth affects the pressure with which the air pushes down on the earth's surface?______________

__________________________________________________

TEACHER DIRECTION E - 17

## FACTORS AFFECTING THE RATE OF EVAPORATION

Materials for groups of three:

1. Asbestos pads (3)
2. Alcohol lamp
3. Box matches
4. Beakers (2-250 ml)
5. Beaker (400ml)
6. Cardboard (5" x 6")
7. Paper towels (2)

ALL OF US HAVE EXPERIENCED BEING CAUGHT IN A RAINSTORM SO WE ALL KNOW THAT WATER COMES OUT OF THE AIR. BUT IF IT COMES OUT OF THE AIR, IT MUST GET INTO THE AIR IN SOME WAY. IT DOES. IT GETS INTO THE AIR BY A PROCESS CALLED EVAPORATION. WATER EVAPORATES FROM OCEANS, FROM LAKES, FROM WET LAND, AND FROM LIVING THINGS GROWING ON THE LAND. THEN THIS WATER VAPOR IS CARRIED BY THE WINDS TO THE PLACES WHERE THE STORMS OCCUR.

IN THIS ACTIVITY WE SHALL INVESTIGATE THREE FACTORS THAT AFFECT THE RATE BY WHICH WATER GETS INTO THE AIR, THE PROCESS OF EVAPORATION. THESE THREE FACTORS ARE WIND, HUMIDITY, AND HEAT. Pass out E-17

Read the activity with the students. Solicit any questions regarding how to proceed, and discuss them. Caution the students about not putting too much water on the asbestos pads - just enough to make wet spots. Tell them to proceed with the activities.

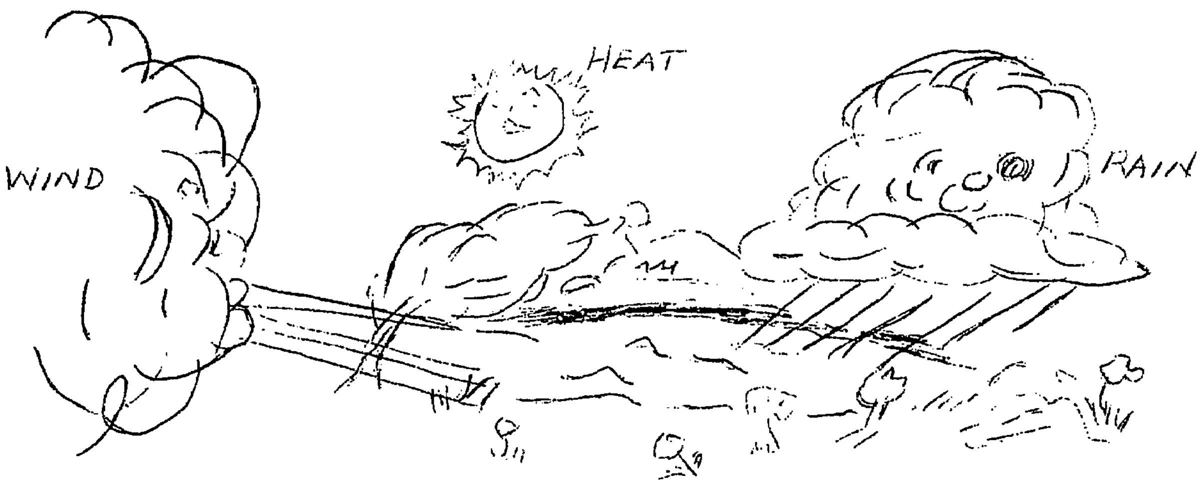
After the students have finished the activity, have them reassemble as a class and discuss with them the answers to the questions they have completed on their activity sheets.

STUDENT E - 17

FACTORS AFFECTING THE RATE OF EVAPORATION

Materials for groups of three:

1. Asbestos pads (3)
2. Alcohol lamp
3. Box matches
4. Beaker (2-250ml)
5. Beaker (400 ml)
6. Cardboard (5" x 6")
7. Paper towels (2)




To find how wind affects the rate of evaporation, place a spot of water on each of two asbestos pads; then fan one briskly and keep the other one in still air. Does the water evaporate from one faster than the other?______________________ Fanning the air removes the water that has evaporated into the air doesn't it?_____ Then the air above the fanned spot would be drier than the air above the spot in still air wouldn't it?__________ What effect does fanning have on the rate of evaporation of water?______________________________________________________

If water evaporates faster into dry air than into wet air we should be able to show this by keeping a moist chamber over one spot while one is open to the air. By taking a crumpled bit of moist toweling in the bottom of a beaker and then inverting it over a spot of water on an asbestos pad we could keep the air moist above the wet spot. Compare the rate at which water evaporates from an asbestos pad into wet air and into the room air. How does water in the air affect the rate of evapor-

Student
page 2

ation of water?________________________________________

To find how heat affects the rate of evaporation, warm one asbestos pad over an alcohol flame. Then with a piece of wet toweling put a wet spot on a cold pad and another on the warmed pad. Does the water evaporate faster from one pad than from the other?______________ How does heat affect the rate at which water evaporates into the air?________________________________________

When your mother hangs out a washing to dry:

1. Will it dry faster on a windy day or a still day?________________

   Why?________________________________________

2. Will it dry faster on a humid day or a dry day?________________

   Why?________________________________________

3. Will it dry faster on a cold day or on a warm day?________________

   Why?________________________________________

4. What is the process by which water disappears into the air as water vapor called?________________________________________

TEACHER DIRECTION E - 18

DUST IN THE AIR

Materials for groups of three:

1. 2 test tubes
2. cork to fit test tubes
3. Test tube brush
4. Brush, paint
5. Pan
6. Cardboard box (shoe)

Materials for class: 1. Projector

YOU HAVE NOW SEEN HOW WATER GETS INTO THE AIR. YOU HAVE SEEN THAT HEAT AND WIND MAKES WATER EVAPORATE FASTER. IN ONE OF OUR EARLIER EXPERIMENTS WE SAW HOW GASES GET INTO THE AIR. HOW DO YOU THINK DUST PARTICLES GET INTO THE AIR? (Wind). Place transparency E-18 (dust storm) on the projector. HOW DID THESE DUST PARTICLES GET INTO THE AIR? DUST STORMS REPRESENT A BIG THREAT TO AREAS WHERE THEY OCCUR. CAN YOU TELL WHY? Discussion. HOW DO YOU THINK THE DUST GOT INTO THIS ROOM? COULD YOU SEE IT COMING IN? Discussion. DUST PLAYS A VERY IMPORTANT PART IN OUR WEATHER. IF IT WERE NOT FOR DUST IN THE AIR NO RAIN WOULD FALL. DOES THIS SEEM STRANGE? ITS TRUE. OUR COLORFUL SUNRISES AND SUNSETS ARE MADE POSSIBLE BECAUSE OF THE DUST IN THE AIR.

MAN PUTS DUST IN THE AIR. EVERY DAY HUNDREDS OF SMOKESTACKS PUT THOUSANDS OF POUNDS OF DUST PARTICLES IN THE AIR. Show transparency E-18.

VOLCANOES PUT DUST IN THE AIR. A GOOD EXAMPLE OF THIS WAS GIVEN BY THE ERUPTION OF A VOLCANO NAMED KRAKATOA in 1883. DURING THIS ERUPTION ABOUT 4 AND A HALF CUBIC MILES OF STONE WERE HURLED INTO THE ATMOSPHERE. ROCKS AND STONES THE SIZE OF A MANS HEAD WERE THROWN UPWARD AT A SPEED OF 2000 TO 3300 FEET PER SECOND AND THE THUNDER COULD BE HEARD AS FAR AWAY AS MADAGASCAR, AN ISLAND NEARLY 3000 MILES AWAY. THE SKY WAS DARKENED FOR DAYS.

Teacher Direction
Page 2

THE FINEST ASH PARTICLES WERE THROWN TO AN ALTITUDE OF 50 MILES. THEY WERE THEN CAUGHT BY AIR CURRENTS AND CARRIED ABOUT 3 TIMES AROUND THE WORLD. FOR MONTHS THEY CAUSED FANTASTIC COLORATIONS OF THE SKY. THE SUN APPEARED IN A VARIETY OF COLORS, EVEN COPPER-RED AND GREEN. EVEN BLUE SUNS APPEARED LIKE THOSE SEEN ON RARE OCCASIONS IN EUROPE WHEN FOREST FIRES RAGE IN CANADA AND THE WEST WINDS CARRY FINE ASH PARTICLES OVER THE CONTINENT.

At this point it would be a good idea to show slides, films, or pictures of some kind of volcanoes.

THE AIR CONTAINS PART OF THE HYDROSPHERE. NOW WE ARE GOING TO SEE IF THE AIR CONTAINS PART OF THE LAND. HAVE YOU EVER NOTICED HOW DUSTY THIS ROOM IS MOST OF THE TIME. WHERE DO YOU THINK THIS DUST COMES FROM? Discussion. (Air) ARE DUST PARTICLES SOLIDS? (Yes) DO THEY TAKE UP ANY SPACE AT ALL? (yes) Discussion. HOW DOES THE DUST GET INTO THE ROOM? (Blown by wind). WOULD YOU BELIEVE THE WIND IS BLOWING PART OF THE LAND AROUND? (yes). Discussion. OF COURSE THIS IS ONLY A SMALL PART OF THE TOTAL LAND AROUND THE SCHOOL BUT THERE ARE PLACES WHERE THE WIND BLOWS SO MUCH OF THE LAND AWAY THAT QUITE A BIT OF DAMAGE IS DONE. SOMETIMES DUST STORMS COVER CROPS OR FARMS WITH UNWANTED DUST. Place transparency E-18 (dust storm) on the projector. WHAT DO YOU THINK MIGHT BE THE RESULTS OF SUCH A STORM? Discussion. ALTHOUGH THERE IS NOT NEARLY THIS MUCH DUST IN THE AIR AROUND THE SCHOOL TODAY, YOU MIGHT BE SURPRISED AT THE AMOUNT THAT IS PRESENT.

Teacher Direction
page 3

YOU MIGHT NOT ALWAYS BE AWARE OF THE DUST PARTICLES BECAUSE OF THEIR TINY SIZE. This question might be injected to stimulate discussion. WHEN DUST PARTICLES ARE IN THE AIR, ARE THEY CONSIDERED PART OF THE LAND OR PART OF THE ATMOSPHERE? Discussion.

Pass out E-18

Read the student directions with the students emphasizing that the procedures must be followed closely. When washing the test tubes, use a test tube brush and rinse in a pan of water containing enough water to submerge the test tube completely. When placing the cork in the test tube remove the test tube from the water keeping the open end down. Insert the cork before lifting the cork upright. This is to prevent dust from entering the test tube.

STUDENT

E - 18

DUST IN THE AIR

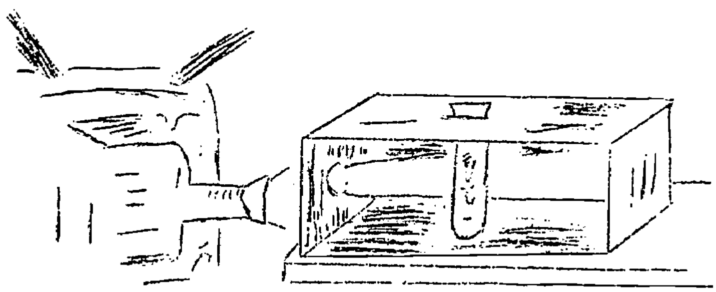
Materials for groups of three:

1. 2 test tubes
2. Corks to fit test tubes
3. Test tube brush
4. Pan
5. Cardboard box (shoe)
6. Brush, paint
7. Tempera paint, black

How much dust is in the air? It depends on a lot of conditions. If the wind is blowing very hard, you can almost see the dust pile up on window ledges or on tables.

You can usually see dust particles at night with car lights, but after a rain you can't see the dust usually. Let's use the lights from a filmstrip projector and darken the room as much as possible to represent night.

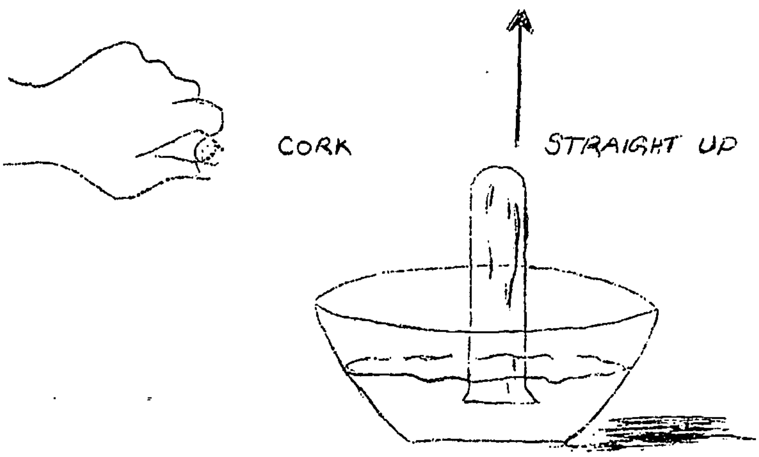
If you can't get the room dark enough, paint the inside of a cardboard box black, cut a hole in one end for the projector lens to fit it. Then place the box on its side.



Fill a pan with water. Rinse one test tube with water to get all air and dust out of it.

Lift the test tube from the water keeping the "open end down". Let most of the water drip out, then insert a cork.

Student
page 2




Dust should not be in the corked, clean test tube. To find out hold the test tube in the light of a filmstrip projector in the "dark box" you have prepared.

Insert a cork in a second, dry, non-washed test tube.

One person is to hold both corked test tubes in the light given off by the projector. The non-washed test tube should have dust floating around in it while the washed test tube should have no dust in it.

Next remove the corks from both test tubes, wait at least five minutes, and test again in the "dark box".

1. Could you see the dust in the air with the room lights on?_______________

2. Why was it necessary to place the cork in the end of the test tube?______

3. Could you see any dust in the bean of light from the projector?__________

4. What happened when you took the cork out of the test tube?_______________

5. Did the dust settle to the bottom of the tube very fast?__________________

   Why or why not?______________________________________________________

# UNIT 3

# WATER

Water is probably the most important factor effecting earth materials. This unit is to familiarize the students with the properties of water and its effect. The physical properties are stressed to show its effect on an Earth surface. The activities are:

E-19 FLOATING AND SINKING
(Floating and sinking is a physical property of differing materials)

E-20 SURFACE TENSION
(Water has a surface attraction that tends to prevent materials from sinking)

E-21 CAPILLARY ACTION
(Capillary tubes showing capillary action)

E-22 CAPILLARITY IN THE EARTH
(Use of chimneys to show Capillarity using sand, gravel and clay)

# UNIT 3 - WATER

The purpose of this unit is to show the role that water plays in the ever-changing structure of the earth. The physical and chemical properties of water will not be investigated except those properties which we use as reference standards when making measurements. The emphasis in this unit is on the effect of water, not the water itself.

## TEACHER RESOURCE

Water serves as a standard of reference for measurements of physical properties of liquid and solids throughout the world. Water is plentiful, inexpensive, and has the same composition (when pure) throughout the world.

Density is a measurement of the weight of a substance in relation to its volume. The density of water is 1 meaning that 1 milliliter of water weighs 1 gram, or 1 g/ml/ The density of other substances can be more or less than 1. If the density of a substance is less than 1, it will float on top of water, such as oil. If the density of a substance is greater than 1, it will sink, or the water will float on the more dense substance.

Impurities dissolved in water will alter the properties of water. Generally, the density will increase upon adding impurities, such as salt, for the water-salt mixture weights more than the water by itself (the volume changes very little). However, the addition of air impurity which will not dissolve in water, such as sand, will not affect the density. When alcohol, which is lighter than water, becomes an impurity of water, then the mixture will have a density of less than one.

By carefully filling a glass with water it is possible to add water until the water level is slightly higher than the height of the glass. It appears that an invisible wall is keeping the water from spilling over the top of the glass. The molecules

of water attract each other quite strongly and tend to keep from being separated. It is the case of a free surface (where the surface of the water is exposed to the air), such as the open top of the glass, this attraction is called surface tension. Surface tension is also responsible forthe balling up of water and mercury in little drops. When alcohol is added to water, the mixture has much less surface tension than water alone.

Water will stick to glass or we say that water will "wet" glass. If a glass tube with a small bore (hole inside the glass tube) is placed in water, the water will go up into the tube a short distance. The smaller the bore the higher the water will rise in the tube. This is called capillary action or capillarity. It is cause by the dual action of the water wetting the glass, the tendency of the water to attract and sticking to it (adhesion), and itself (surface tension). Mercury will not wet glass and will not exhibit capillarity even though the surface tension of mercury is high. The thermometer does not involve capillarity. A capillary tube is open on both ends while a thermometer is closed on one end and the other end is submerged in mercury. The expansion and contraction of mercury due to changes in temperature causes the thermometer to function.

Topic 1 - A less dense substance will float on a more dense substance. Density can be changed by dissolving some material in the liquid.

HOW MANY OF YOU HAD EGGS FOR BREAKFAST THIS MORNING? Pause. DOES AN EGG FLOAT IN WATER? Discussion. IS IT EASIER TO SWIM IN THE OCEAN THAN IN THE RIVER? Discussion. Yes. WHY? The students may guess that the salt in the ocean increases buoyancy, but don't tell them definitely yet. HOW DOES THE SERVICE STATION MAN CHECK YOUR BATTERY TO SEE IF IT IS ANY GOOD? Uses a hydrometer or floating tube which indicates the density of the acid in the battery. A charged battery will have a higher density than a low or discharged battery. Emphasize the point that the tube floats in the acid. LETS FIND OUT IF AN EGG WILL FLOAT OR SINK. WHILE WE'RE AT IT, LETS FIND OUT HOW TO CHECK OUR BATTERY.

Pass out E-19.

TEACHER DIRECTION E-19

## FLOATING AND SINKING

Materials for groups of three:

1. Fresh egg
2. Two beakers, 250 ml
3. Table salt, 3 teaspoons
4. Grease pencil
5. Plastic soda straw
6. Moulding clay (from art dept.)
7. Lead shot, 10 size
8. Graduated cylinder

Materials for instructor demonstration:

1. Graduated cylinder
2. Mercury (20 ml)
3. Carbon tetrachloride (20 ml)
4. Water (20 ml)
5. Kerosene (20 ml)
6. Steel ball (1/2 inch diameter)
7. Ebony (1/2 inch cube)
8. Paraffin (1/2 inch cube)
9. Cork (1/2 inch cube)

Instruct the students to handle the egg carefully - it will break. Be careful not to break the straw when slowly pushing it into the path of clay. The clay should remain inside the straw acting as a stopper and adding weight. The clay on the outside of the straw should be removed and collected as you circulate among the groups. If a mistake is made in marking the straw with the grease pencil, the mark can be removed by wiping gently with a paper or cloth towel. Urge the students to do their experiments quickly so there will be enough time to discuss their results.

WILL AN EGG FLOAT IN WATER? Discussion. YOU HAD THE SAME AMOUNT OF WATER IN BOTH BEAKERS, DIDN'T YOU? Yes. THEY PROBABLY WEIGHED THE SAME BEFORE YOU PUT THE SALT IN THE SECOND BEAKER. Place transparency E-19 on the overhead projector showing a beaker of drinking water and adding salt to a second beaker. WHAT HAPPENED TO THE WEIGHT OF THE BEAKER OF WATER WHEN YOU ADDED THE SALT? Increased. DID THE VOLUME INCREASE, ALSO. Very little. THEN THE SALT WATER WEIGHS MORE THAN THE PURE WATER, DOESN'T IT? Yes. THE SALT WATER IS MORE DENSE, OR HEAVIER, AND THE EGG FLOATED.

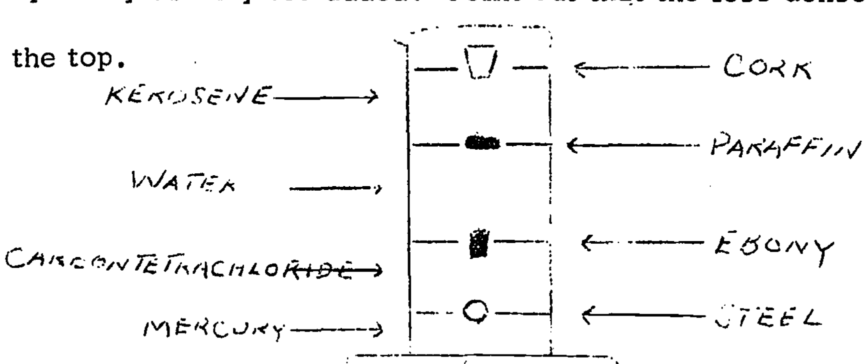
Teacher Direction

Page 2

THE SODA STRAW ALSO FLOATED HIGHER. HOW COULD WE USE A STRAW TO MEASURE THE DENSITY OF A LIQUID? Discussion.

DO YOU BELIEVE THAT A SOLID STEEL BALL WILL FLOAT? Discussion. LET'S SEE. Gently roll a steel ball down the inside of a graduated cylinder. Lean the cylinder so that the ball rolls slowly. Then gently pour 20 ml of mercury down the side of the cylinder. The steel ball will float on the mercury. YES. A STEEL BALL WILL FLOAT, pause. ON MERCURY. MERCURY IS A VERY HEAVY LIQUID. IS MERCURY LESS DENSE OR MORE DENSE THAN IRON? Discussion. Place an acetate on the overhead projector showing the density of mercury, and iron with spaces for the other substances. THE DENSITY OF MERCURY IS 13.6 AND THE DENSITY OF IRON IS 7.5. SINCE IRON IS LIGHTER, IT WILL FLOAT IN MERCURY. Discussion. Explain that mercury is 13.6 times heavier than water and that iron is 7 1/2 times heavier than water (water has a density of 1). A GALLON OF WATER WEIGHS 7 1/2 POUNDS. THEREFORE, A GALLON OF MERCURY WOULD WEIGH 102 POUNDS (7 1/2 times 13.6 = 102.)

Continue the demonstration by carefully adding carbon tetrachloride (20 ml), ebony which will float on the carbon tetrachloride, water (20 ml) with a little ink or coloring, paraffin, kerosene, and finally the cork. Write in the densities of each on the transparency as they are added. Point out that the less dense substances are nearer the top.



STUDENT

E - 19

FLOATING AND SINKING

Materials for groups of three:

1. 2 eggs (fresh)
2. Beakers (250 ml)
3. Table salt (NaCl)
4. Grease markings pencil
5. Plastic drinking straw
6. Clay
7. 10 lead shot
8. Graduated cylinder

When will a rock sink in a liquid? When will fresh eggs float in water? The answer can be found in this activity.

Add 150 ml water to each of two beakers. Number the beakers 1 and 2.

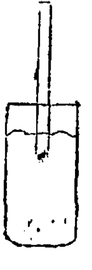
Form a patty of clay one-half inch thick. Stick one end of the straw into the clay. This will stop up one end. Then place the stopped-up end of the straw in the beaker of water and drop lead shots down until the straw stands straight up, but is still floating. Using a grease pencil put a mark on the straw.

Straw at water level. Test the water level mark to make sure it is the same in both beakers of water. After testing the water mark, set the straw aside being careful not to spill any shot.

Place an egg in the first beaker of water. The egg should sink. Does it?

To beaker number 2 add about 3 teaspoons full of salt and stir well.

After adding the salt, use your straw to find out if the water mark is still the same for both beakers.



Student
page 2

Make a drawing of the two beakers showing the position of the egg and the weighted straw in (1) fresh water and (2) salt water.

1. Would it be easier to swim in the ocean than in fresh water?

2. Would a boat sink deeper in salt water than in fresh water?

It appears that things float higher in salt water than in fresh water.

TEACHER RESOURCE

IN THE LAST ACTIVITY, WE SHOWED FLOATING DEPENDS ON DENSITY. BUT LETS SEE IF ANYTHING ELSE AFFECTS FLOATING. CAN YOU THINK OF ANY WAY YOU MIGHT BE ABLE TO FLOAT A MORE DENSE MATERIAL ON A LESS DENSE LIQUID? Shape, such as in a boat, will probably be mentioned. Discuss. DO YOU BELIEVE THAT YOU CAN FLOAT A PIN OR NEEDLE OR RAZOR BLADE ON WATER? IT TAKES A LOT OF SKILL TO DO IT. I READ IN A SCIENCE BOOK ONE TIME THAT IT COULD BE DONE. I THINK I CAN DO IT. HOW ABOUT YOU? Discussion. LETS FIND OUT.

TEACHER DIRECTION E - 20

SURFACE TENSION

Materials for groups of three:

1. Two beakers (250 ml)
2. Sewing needle
3. Pin
4. Razor blade, double edge
5. Fork
6. Thread (2 inches)
7. Bar of soap (small)

Remind the students to carefully wash the beakers and rinse them well. The needle should be placed gently on the surface of the water with the fork. Slowly and gently remove the fork. Several attempts may be necessary. Place an acetate showing the procedure on the projector. Circulate among the groups offering advice, but not assistance. After returning the equipment to the proper place, have the students reassemble for a class discussion.

DID THE NEEDLE FLOAT ON THE WATER? Discussion. WHY? Some liquids appear to have a thick film over their surface which will support a small amount of weight. Once broken, then the needle will sink. WHAT HAPPENS WHEN YOU TOUCH THE WATER WITH SOAP? Discussion. The soap breaks the surface tension inside, but not outside a floating piece of string. The surface tension pulls out on the string from all directions.

Teacher Direction
page 2

If a larger amount of soap were placed in the water, the string may sink.

Soap breaks the surface tension of water allowing the water to "wet" your hands and clean them. "Wet" water will not "ball up" like pure water.

WHAT WOULD HAPPEN IF YOU PUT A DUCK IN SOAPY WATER? The soapy water would wash the oil off the duck's feathers allowing them to get wet. It would sink much deeper in the water.

More applications of soapy water could be discussed Point out that soap is not the only thing that effects the surface tension of water. Many other substances - chemicals - could do the same thing.

DID YOU SEE THE SURFACE OF THE WATER BEND UNDER THE WEIGHT OF THE NEEDLE? Discussion. Yes.

WOULD YOU EXPECT TO SEE THIS IN A POND? HAVE YOU EVER SEEN SMALL LEAVES FLOATING ON A POND? Yes.

WOULD YOU EXPECT TO SEE THIS IN A SWIFTLY FLOWING RIVER? No. The water is moving too fast and too turbulent which breaks the surface tension.

HOW COULD THE CHEMICAL CONTENT OF A LAKE, RIVER, OR OCEAN BE CHANGED? If vlowing, the water will come into contact with different minerals found in different regions which could dissolve into the water. The chemical content of the air is affected by various pollutants e.g. waste from automobile exhaust. Smoke from industrial plants (chemical fertilizer & paper).

STUDENT E - 19

SURFACE TENSION

Materials for groups of three:

1. 2 beakers (250 ml)
2. Needle (steel)
3. Pin
4. Razor blade
5. Fork
6. Thread (2 inches)
7. Bar of soap (small)

Water, like other liquids, appear to have a thick film that covers the surface. This apparent film is called surface tension. The surface tension will sometimes prevent materials from sinking. If the surface tension is great enough to prevent a material from entering the water, the material will lay on top until the wind, shaking or stirring, or a new chemical is added to reduce the surface tension.

Wash two beakers very thoroughly. Make sure the beaker is rinsed with water, leaving no soap scum.

After washing the beakers, use a fork to gently place a dry, clean pin on the surface. Place a needle on the tines of a dinner fork and gently break the surface of the water in the beaker with the fork. If you are careful the needle will float as you slowly take the fork away. Do the same with a razor blade.

Make a drawing showing how the water blends.

Student
page 2

Can you see the surface of the water bend under the weight of the needle?

Would you expect to see this in a river? Why?

Would you expect to see this in a pond? Why?

To the second beaker, make a loop with thread and float it on the water. Then touch the surface of the water inside the loop with the bar of soap. What happened? Why?

Could the surface tension of a pond be changed by streams running into it? How could it be changed?

How may the chemical content of a lake, river, or ocean be changed?

TEACHER RESOURCE

I WENT TO THE DOCTOR A WHILE BACK AND HE TOOK A SAMPLE OF MY BLOOD FOR TESTING. THE WAY HE COLLECTED THE BLOOD WAS INTERESTING. Place transparency E-21 on the projector showing the pricking of a finger. FIRST, HE TOOK A SHARP POINT AND KNOCKED A HOLE IN MY FINGER. MY COMMENT TO HIM MUST HAVE MADE HIM MAD, BECAUSE HE PUNCHED ANOTHER HOLE IN THE SAME FINGER. THEN HE SQUEEZED SOME BLOOD OUT. Place second transparency on the projector showing the collection of blood in capillary tube. THEN HE TOOK A SHORT PIECE OF GLASS TUBING AND, BY JUST TOUCHING THE BLOOD WITH THE END OF THE TUBE, FILLED IT UP. HE CALLED THIS A CAPILLARY TUBE. HAVE YOU EVER SEEN ANYTHING LIKE THAT BEFORE? Discussion. Describe the tube as having a very small hole in it.

ITS HARD TO BELIEVE THIS UNLESS YOU ACTUALLY SEE IT. I HAVE SOME CAPILLARY TUBES LIKE THE DOCTOR USED. HOW WOULD YOU LIKE TO COLLECT SOME BLOOD? Pass out E-21.

TEACHER DIRECTION E - 21

CAPILLARY ACTION

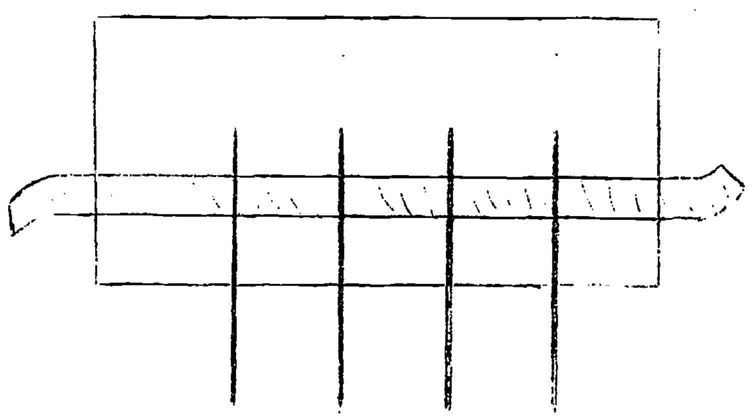
Materials for groups of three:

1. Four capillary tubes
2. Cardboard (6" x6")
3. Masking tape
4. Beaker (250 ml)
5. Food coloring (red)

Place transparency E-21 on the projector showing the completed assembly. The tubes must be taped to the cardboard in such a manner that the ends extend into the beaker the same depth. If the tubes are spread out too much, they cannot all be placed in the beaker at the same time. Encourage the students to try independent investigations. The tubes break easily.

Teacher Direction
Page 2

After completion of the activity, discuss the activity and questions at the end. Emphasize the point that the soil is porous and these tiny openings act as capillary tubes to transport water through the soil.



STUDENT

E - 21

## CAPILLARY ACTION

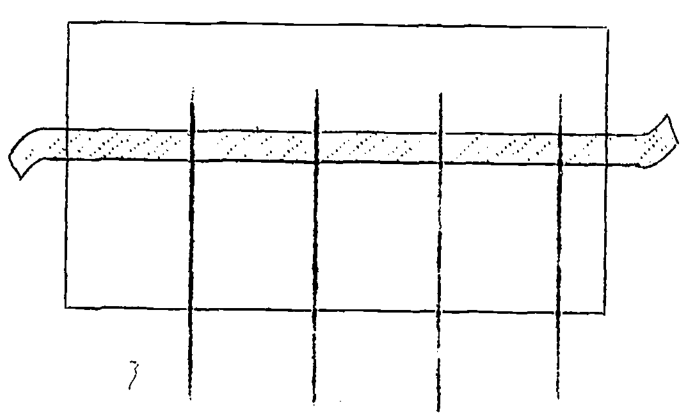
Materials for groups of three:

1. 4 capillary tubes
2. Cardboard (6" x 6")
3. Masking tape
4. Beaker (250 ml)
5. Food dye (red)

Water can run upwards. Of course, a river can't run up hill, nor can a stream run away from a river. Streams run downhill to rivers. and the rivers flow toward the ocean. But water in the earth can move upward by a process called capillary action. Carefully place a sponge on the end in a shallow pan of water. Notice that the sponge becomes wet above the water level in the pan. The water moves upward in the sponge material. It will rise like this on any porous material it wets. Water moves upward like this in soil. This is called capillary action.

Fill a beaker with water and add enough food dye to color the water a bright red.

Place the four capillary tubes on a piece of cardboard one quarter inch apart and extending over one end about one inch. Then tape the tubes securely to the cardboard.



Student
page 2

Place the ends to the capillary tubes in the beaker of water.

1. Make a drawing of what you observe.

2. Did water run uphill?

3. If you place a dry sponge in a pan of water, how does it soak up water?

4. How could you explain soil next to a pond being very wet above the water level of the lake?

TEACHER DIRECTION E - 22

## CAPILLARITY IN THE EARTH

Materials for groups of three:

1. 4 chimneys
2. 4 pieces of cheesecloth (4 x 4)
3. Pan of water
4. Scissors
5. Food dye
6. 4 rubber bands
7. Sand (fine)
8. Sand (coarse)
9. Pea gravel
10. Clay
11. Grease pencil

Capillarity occurs in the earth similar to capillarity in the tubes as demonstrated in E-21. The pore spaces between the grains of sand or gravel provides the openings for the water to move upward. The water will move upward the most in clay, then fine sand. coarse sand and least in pea gravel. The food dye will make the water movement easier to see.

Make sure the clay, sand and gravel are dry.

Pass out E-22.

Using transparency E-22 discuss setting up the apparatus. Make sure the cheesecloth is secured tightly. Caution the students not to pack the material in the chimneys.

Upon completion of the activity, discuss the results. If time allows let the students mix the various materials and determine the results or use as a demonstration.

STUDENT

E - 22

## CAPILLARITY IN THE EARTH

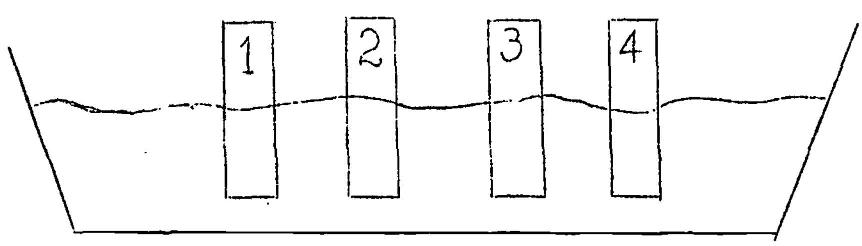
Materials for groups of three:

1. 4 chimneys
2. 4 pieces of cheescloth (4 x 4)
3. Pan of water
4. Scissors
5. Food dye (red)
6. Cardboard ( 6 x 6)
7. 4 rubber bands
8. Sand (fine
9. Sand (coarse)
10. Pea gravel
11. Clay

Lets see if capillary action occurs in earth materials. What kind of material would you expect to exert the most force of capillary action?

Number the chimneys 1,2,3 and 4.

Cover one end of each chimney with cheescloth and secure tightly with a rubber band.



Student
Page 2

Fill chimney number one full of clay.

Fill chimney number 2 full of fine sand.

Fill chimney number 3 full of course sand.

Fill chimney number 4 full of pea gravel.

To a pan of which contains about two inches of water add dye to color the water bright red. Stand the chimneys in the pan of water and watch for capillary action for ten minutes. Then draw what you observe.

1. What kind of material exerted the most force of capillary action? How can you tell?

2. If you lived on a big farm and if this farm you had four hills that were stripped by a bulldozer to remove all the trees, bushes, grasses, etc, which hill would water evaporate faster from if one hill was clay, one was fine sand, one was coursesand and one was gravel?

## UNIT 4

## WATER CYCLE

Free water in the hydrosphere, lithosphere, and atmosphere is part of a never ending cycle. The water movement from land to sea to air, or to differing environments provides one mechanism for weathering and erosion.

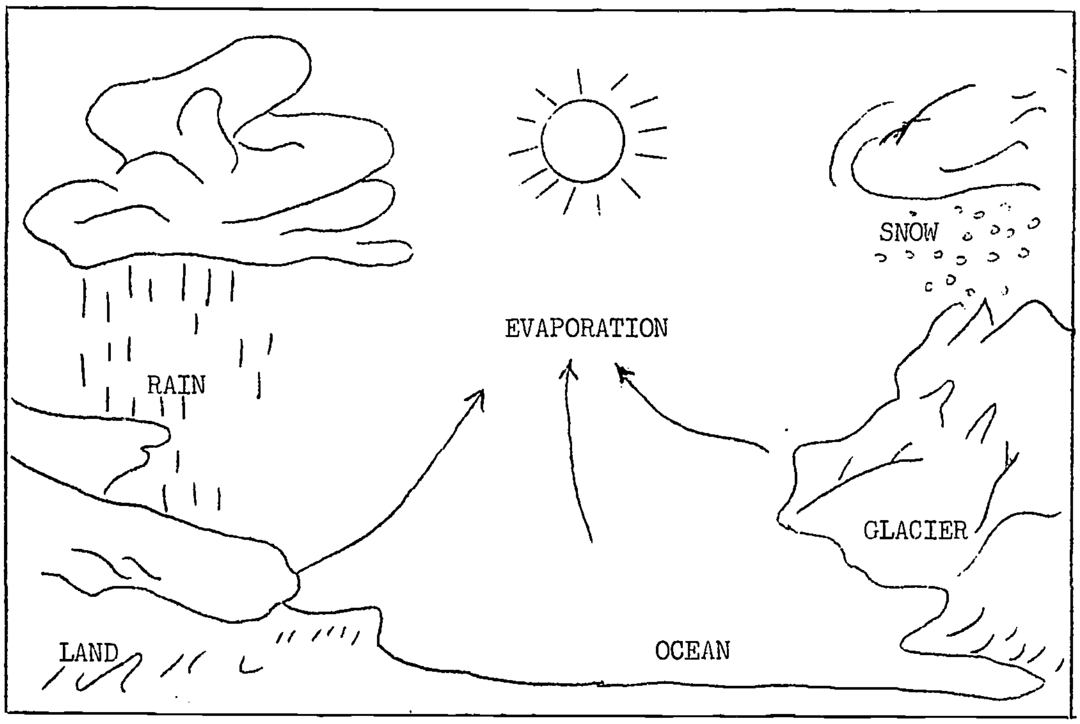
The water cycle is the product of changing environmental conditions. Whereby the water movement from oceans to atmosphere and back to the earth demonstrates the interrelatedness of the system called the water cycle.

| | |
|---|---|
| E-23 | MOVEMENT OF WATER IN THE EARTH<br>(Water retention ability of sand and gravel) |
| E-24 | GROUND WATER<br>(Using chimneys to show water movement in sand) |
| E-25 | INFILTRATION AND TRANSPORT<br>(Showing underground flow of water) |
| E-26 | THE EARTH CLEANS ITS WATER<br>(Use of charcoal, sand and gravel to show filtration) |
| E-27 | THE WATER FROM THE LAND INVADE THE OCEANS<br>(Reading activity introducing some of the characteristics of the ocean) |
| E-28 | TEMPERATURE DIFFERENCES CAUSES SUBSURFACE CURRENTS<br>(Use of a pop sicle to demonstrate effect of differing temperatures) |

# UNIT 4 WATER CYCLE

The free water in the oceans, lakes, rivers, glaciers, water within the pore spaces of rocks and soils, and the water vapor in the atmosphere is part of a never ending, interrelated system. The movement of water within an environment and from one environment to another provides the energy, erosion, and transportation. This system of water movement from oceans to atmosphere, to the land and back to the ocean is called the "Water Cycle."

Water may make intermediate stops in the cycle. Part of the surface and ground water may be transferred back to the atmosphere by evaporation before it reaches the oceans. Water may be temporarily held in plants and animals. Ground water may supply lakes and rivers or may be supplied by them. Glaciers may feed streams and lakes, or melt within the warmer oceans water, or evaporate into the atmosphere.



Topic I - The waters on the continents infiltrate the land. or run off in rivers, or evaporate into the atmosphere.

The Earth's main source of fresh water is rain and snow. The amount of rain and snow varies from place to place, season to season, and year to year. Ocassionally rains may fall in torrents at the rate of as much as 1 to $1\frac{1}{2}$ inches per hour.

What may happen to rain which falls on the land? It may soak into the ground, it may run off in streams or rivers to the oceans or it may evaporate. About 36 percent of the water from rain and snow runs off in rivers: about 64 percent evaporates from the soil and plants. One might say the largest "river" in the world is the atmosphere.

TEACHER RESOURCE

The largest amount of stored fresh water on the Earth is frozen in the ice caps. If these ice caps melted it is thought by some that the water level of the oceans would rise from 80 to 160 feet submerging most of Florida.

If rain fall is light, most of the precipitation will probably return to the atmosphere directly through evaporation. If the rain fall is heavy and continuous as in certain tropical regions much of it will filter into the soil and supply moisture for plants. If the soil becomes saturated and infiltrations and underground seepage cannot keep pace with the falling rain water, it will run off into lower areas - in streams and rivers, eventually reaching the ocean. Of the rain which falls to the earth, approximately 54-97% evaporates from the land or plants by the process of transpiration: 2-27% drains to streams: 1-20% infiltrates into the earth.

Water moves downward into soil pores. The solid rocks below the soil called bedrock may contain fractures, cracks, or other openings that are filled with water. The water may remain in the rocks for long periods of time. It moves toward dryer portions of sand and clay by capillary action. It moves toward lower elevations by gravity, moving below the surface and reappearing at the surface into lakes, the ocean or springs. Eleven percent of the precipitation falling on the Earth reaches streams or lakes by moving below the surface.

TEACHER DIRECTION E - 23

## MOVEMENT OF WATER IN THE EARTH

Materials for groups of three:

1. Graduated cylinder (100 ml)
2. 2 chimneys
3. 2 one hole rubber stoppers
4. 2 Glass tubes (2 inches)
5. Fine sand
6. Pea size gravel
7. Cheescloth
8. 2 beakers (250 ml)
9. Rubber tubing (3 inches)
10. Pinch cock

The movement of water in the Earth originates from precipitation, soaks into the Earth, then moves under the surface. This activity will demonstrate water movement and water retention in the land. (the lithosphere).

THE EARTH CAPTURES WATER FROM THE ATMOSPHERE, BUT CANNOT HOLD IT FOREVER. LETS TALK ABOUT WATER ON AND IN THE EARTH. WHERE DO THE CONTINENTS GET THEIR WATER? Discussion: Rain and snow from the atmosphere. WHAT ARE 3 THINGS RAIN OR WATER MAY DO AFTER REACHING THE CONTINENTS? Discussion. It may soak into the ground. It may run off as streams or rivers. It may evaporate. THE AMOUNT OF RAIN FALL ON A CONTINENT VARIES FROM DAY TO DAY, PLACE TO PLACE, SEASON TO SEASON, AND YEAR TO YEAR. RAIN FALLS AND ABOUT TWO-THIRDS OF IT EVAPORATES, THE REMAINING ONE THIRD SOAKS INTO THE GROUND. OF COURSE, YOU CANNOT SAY THAT THIS IS ALWAYS TRUE. IF WE GET A VERY LIGHT RAIN, MOST OF IT WILL EVAPORATE. WHAT WOULD HAPPEN IF YOU GET A BIG DOWN-POUR? Discussion. If the soil is dry, a lot of it will soak into the ground. On the other hand if the soil is very wet, most of the water will run off. Also discuss the thickness of soil, or depth of the bedrock. Will materials and plants in and on the soil, have any effect on this water? Discussion. Vegetation reduces runoff, but aids evaporation. The size and properties of the material that make up the soil has an effect. The permeability of large particles such as gravel is greater than smaller particles. The compactness of the soil effect permeability.

LETS OBSERVE HOW THE SIZE OF THE EARTH MATERIALS AFFECT WATER FLOW INTO AND IN THE EARTH.

Pass out E-23

Using transparency E-23, read the student directions as the students read silently. Interject questions to stimulate predictions. Discuss. the tables before the students start setting up their apparatus.

Upon completion of the activity assemble for a class discussion. Use prepared acetates to discuss the findings. Point out the relationship of pore space and transportation of underground water.

There are several factors that determine the rate water enters the soil?

1. Water beneath the soil must move downward to provide space for entering water.
2. Size of pore spaces - the smaller the pore the slower the rate.
3. Connection of the pore space to prevent trapping the water.
4. Plant cover increases the infiltration.

STUDENT E - 23

# MOVEMENT OF WATER IN THE EARTH

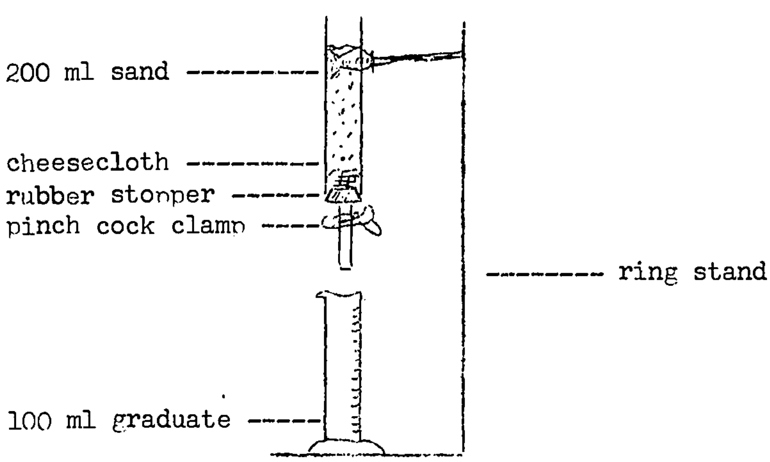
Materials for groups of three:

1. Graduated cylinder (100 ml)
2. 2 chimneys
3. 2 one-hole stoppers
4. 2 glass tubes (2 inches)
5. Fine sand
6. Pea gravel
7. Cheesecloth
8. 2 beakers
9. Rubber tubing (3 inches)
10. Pinch cock clamp

Water falls on the continents as rain and snow (precipitation) then it may soak into the earth, or run off in streams, or evaporate into the air. It is difficult to tell what rain water will do unless you know many things about the place where it falls. Things you would want to know are a description of the soil or ground, how much water, the temperature and the amount and kind of plant. The materials at the surface affect the amount which sinks in.

How fast does ground water move through gravel? Through sand? How much water can the gravel hold or capture? How much water can sand hold? Which will hold more water? Sand or gravel and why? Lets find out.

Set up your apparatus as shown in the drawing. Do not add sand or gravel until the apparatus is set up.



Student
Page 2

Make sure the glass tubing inserted in the cork is covered by cheescloth.

Add 200 ml of sand to one tube and 200 ml of gravel to the second tube.

Clamp off the rubber tubing with the pinch cock clamp.

INVESTIGATION I

Add water until water covers the sand and gravel. Measure the amount of water poured into each tube and record your findings. Then drain the water off by opening the pinch cock for five minutes, then close the rubber tube with the pinch cock clamp.

| TUBE WITH SAND | TUBE WITH GRAVEL |
|---|---|
| Amount of water added_________ml | _____ml Amount of water added |
| Amount of water drained off_______ml | _____ml Amount of water drained off |
| Amount of water held by the sand____ml | _____ml Amount of water held by gravel |

1. Did the sand or gravel hold more water?

2. Did the sand or gravel have more space between the particles?

3. From your findings predict whether a fine clay would hold more or less water than the sand?

Student
Page 3

INVESTIGATION 2

Using the same apparatus, find out how the sand and gravel affect the flow of water. Record your results in the table.

You are to time the number of seconds it takes to pour 200 ml of water through the sand, and the number of seconds required to pour 200 ml of water through the gravel. One person will have to be the "timer" telling another person when to start and recording the time when water stops flowing.

Place a beaker under each tube to catch the water.

| SAND | GRAVEL |
|---|---|
| Time water was added__________ | Time water was added___________ |
| Time water quit running__________ | Time water quit running_________ |
| Number of seconds difference_______ | Number of seconds different_____ |

Student
page 4

1. Did the water run through the sand or gravel faster? How much faster?

2. Which layer in the Earth will transport water underground best, sand, or gravel?

   or clay? Why?

3. Predict whether clay will transport water faster or slower than sand.

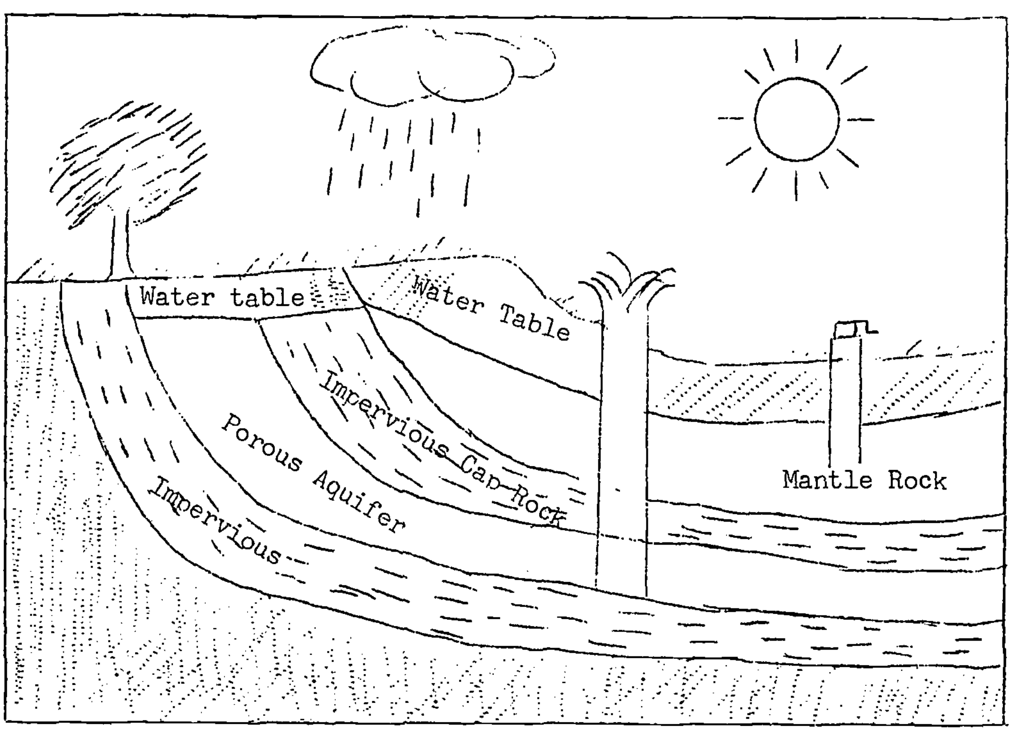
TEACHER DIRECTIONS E - 24

GROUND WATER

The students will need a general discussion of the ideas expressed in the reading activity. Use transparency E-24 in discussion to demonstrate water entering the Earth, being transported downward and "side ways" then returning to the surface available for evaporation into the atmosphere.

After the student reads the activity, answer the questions at the end of the activity referring frequently to the written context.

If interest warrants further investigation. further investigation can be accomplished by interpreting a local water budget in Investigating the Earth. ESCP 1967, pages 218 - 223. Attempt this investigation only if students interest is high.



STUDENT E - 24

## GROUND WATER

What determines the speed at which water enters the soil? There are several factors. Water can enter no faster than the water beneath the surface can move downward. If after a heavy rain the ground is saturated and cannot hold any more water, the rain water will run off without moving into the ground. This also occurs during the floods and following the melting of snows. The pore spaces beneath the surface must transport the water and: therefore, limit the amount of water that can enter the ground. The size of the pore spaces in the ground affect the rate at which water can enter. If the pore spaces are very small, like those in clay, the water moves slowly.

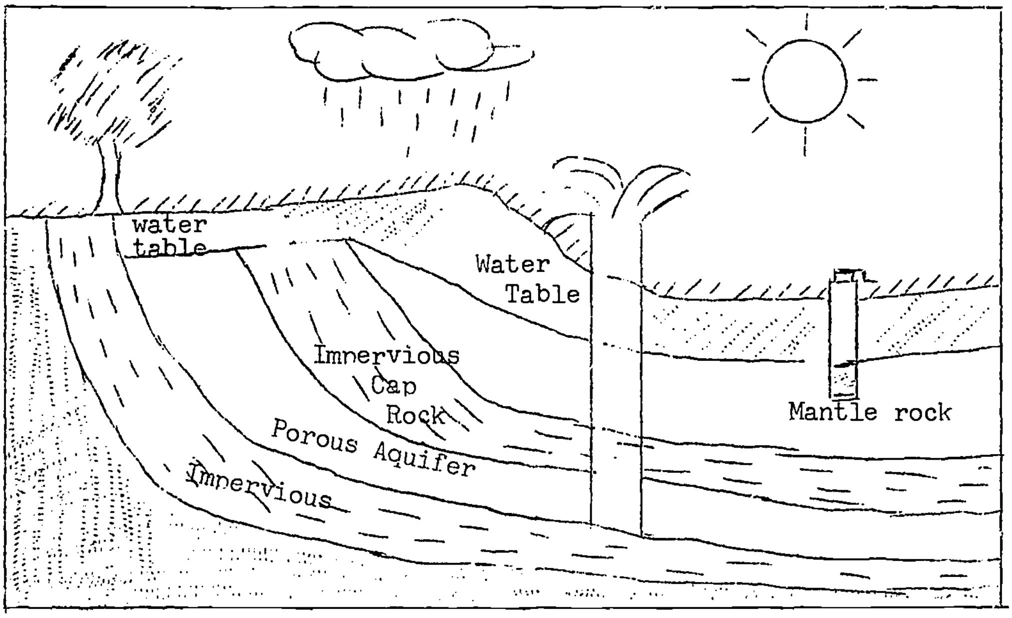
The ground surface also affects the speed with which water can enter. Most soils contain sand and clay that have openings like a bag of marbles of different sizes. The big pores allow water to enter faster than the smaller pores. As water enters, and moves downward it leaves films of water on the particles leaving passages for air to circulate. The plants use these tiny drops of water by taking the water into their roots.

Water can not keep going downward forever: it will run into materials into which it cannot pass through as fast as it enters. When this area will hold no more water, we say it is saturated. This is called the "Ground Water Zone." The top of this zone is called the "Water Table." To get water from this zone, cities and farmers drill wells down below the water table into the ground water zone.

Most of the time the ground water zone is not level as the water flows downhill due to the force of gravity. If the ground water zone runs into a lake or stream, then the lake or stream is said to be spring fed.

Student
page 2

Flowing artesian wells are thos which the water rises above the surface of the ground.




The out flow of ground water depends on how much water flows into the ground and how much water can flow through the water carrying bed. During periods of drought the water table is lower than in the rainy seasons. Farmers using well water for irrigation then find the water table has dropped and the well must be drilled deeper.

Many have become worried about water pollution of the ground water zone.

How can water be polluted? What will happen if this zone is polluted? How can it be prevented? What places have you seen where water is being polluted? What do you think are the causes? What has to be done to stop this?

TEACHER DIRECTION E - 25

INFILTRATION AND TRANSPORT

Materials for groups of three:

1. 2 chimneys
2. 3 ring stands & clamps
3. Clear plastic pan
4. Fine sand
5. Table salt (NaCl)
6. Food dye (red)
7. Beaker (250 ml)
8. Grease pencil
9. Heat lamp

This activity will support the reading activity E-23. A full period will be necessary for obtaining results. For more dramatic results leave the apparatus assembled overnight.

Pass out E-24

Use the student directions and a quickly prepared review on E-23. Instruct the students to assemble the apparatus as directed.

Upon completion of the activity reassemble for a class discussion. Discuss the questions at the end of the activity.

Some points of interest are if the pan was raised at the end containing the Georgia tube and a well was drilled between the tubes, this could be an artesian well. The lamp on the Florida side helps the capillary action, but it can also represent a temperature difference. The lamp not necessary for results.

This activity should be interesting. It will also provide an opportunity to clinch the relationship of water infiltration, transportation, and evaporation.

STUDENT E - 25

## INFILTRATION AND TRANSPORT

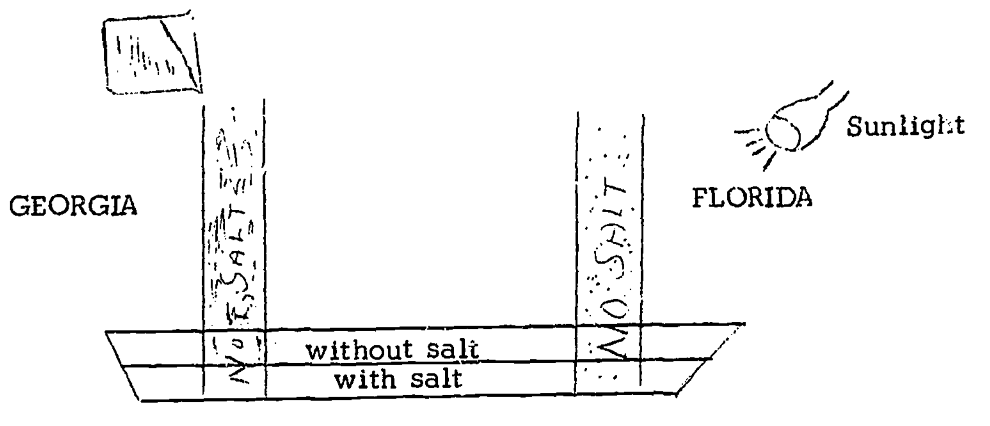
Materials for groups of three:

1. 2 chimneys
2. 3 ring stand and clamp
3. Clear plastic pan
4. Fine sand
5. Table salt (NaCl)
6. Food dye (red)
7. Beaker (250 ml)
8. Grease pencil
9. Heat lamp

Lets see how ground water flows, laboratory style. You must follow directions closely or this activity will not work well. We are going to attempt to represent the entering of water into the ground, called infiltration, and watch it come up in another location. Just for realism, lets label one chimney "Georgia" to represent soil in that state, and water will infiltrate it. We'll call the chimney that the water will come up "Florida". Use the grease pencil to label these tubes.

Place a one inch layer of fine sand in a pan. Pour salt evenly over the sand until it covers the sand, then mix thoroughly.

With your ring stands and clamps erect two chimneys upright and extending into the sand and salt. Be sure the tubes do not touch the bottom of the pan.



Student
Page 2

Add about three inches of clean dry sand to the chimneys.

Add a layer of dry sand 2 inches thick over the layer of sand and salt in the pan. Be sure the ends of the chimneys remain in the lower layer of sand. Shine a heat lamp on the "Florida" tube.

Mix some dye in a beaker full of water and pour it into the "Georgia" tube. More water and dye may be needed, so after pouring the water into the chimney add dye to the beaker of water again. You may have to shake the "Georgia" tube a little to start the water flowing properly.

1. Did the water reach Florida?

2. Is the water coming to Florida via ground water? How can you tell?

How did the water come up the Florida tube: (Capillary Action)

TEACHER DIRECTION E - 26

# THE EARTH CLEANS ITS WATER

Materials for groups of three:

1. Chimney
2. cheesecloth
3. Rubber stopper (1 hole)
4. Glass tubing (2 inches)
5. Fine sand
6. Coarse sand
7. Pea gravel
8. Charcoal
9. Mortar and pestle
10. Beaker (250 ml)
11. Dirt

This activity will show how the earth cleans its water for people to drink. The filtering processes of soils is used by the water processing industry, swimming pools, etc. The suspended materials coagulate preventing the suspended materials from moving through the pore spaces. In other words, the contaminate are filtered out. Materials in solution must react chemically and precipitate out in the pore spaces if they are to be removed. The presence of bacteria and solvable materials are ever present in spring watcr and testing is required for detection.

HOW CAN WATER FALL ON THE GROUND, GET DIRTY, SINK INTO THE GROUND ALL THE WAY TO THE GROUND WATER ZONE, THEN PROVIDE CLEAN DRINKING WATER WHEN IT RETURNS THROUGH A WELL? Discussion.

Do not tell the students the answer. Accept all answers. LETS TRY AN ACTIVITY THAT WILL GIVE US SOME ANSWERS.

Pass out E-26

Upon completion of the activity return for a class discussion. Answer all questions that may arise, but do not try to explain the technicalities of the process unless asked.

Films and filmstrips explaining ground water action should be shown.

STUDENT E - 26

## THE EARTH CLEANS ITS WATER

Materials for groups of three:

1. Chimney
2. Cheescloth
3. Rubber stopper (1 hole)
4. Glass tubing (2 inches)
5. Fine sand
6. Coarse sand
7. Pea gravel
8. Charcoal paste
9. Mortar and pestle
10. Beaker (250 ml)
11. Dirt

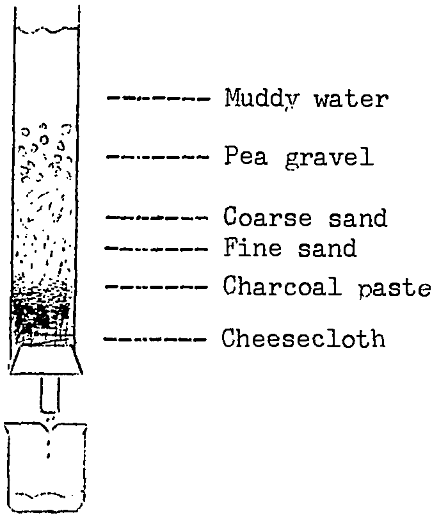
Water falls on the Earth, gets dirty and soaks into the ground. If it reaches the ground water zone it then may become drinking water. The question of great importance is how does muddy water purify itself. Can the Earth filter all of the water before it flows out of a well to become drinking water. In most cases the water is pure enough to drink. One thing of common interest now is soap. It seems the Earth doesn't have the ability to filter out soap very well and as much soap that is used and eventually gets into the ground water table has made some people upset. How would you like to have a glass of soap suds to drink?

Lets make a model of the earth's layers and investigate its filtering power.

Set up your apparatus as shown in the diagram. Attach a chimney to a ring stand and place in layers the following:

1. Cheesecloth
2. Pea gravel
3. Coarse sand
4. Fine sand
5. Charcoal paste (ground up charcoal mixed with water)
6. Then add 200 ml of muddy water

Student
page 2




1. Would it be safe to drink the water?

2. What is the difference in this filter and what you would expect to find in the earth?

3. What happened to the dirt in the water? Why?

Topic 2

Although the ocean appears to be a uniform body, changes occur in the ocean because of differences in depths, amount of salt (salinity), the land materials draining in, and the wind.

The earth's major water reservoir is the ocean. Many factors make the ocean a varied environment such as great differences in depth and temperatures differences at these depths. Winds cause currents on the surface of the ocean. Land materials draining into the ocean change the chemical composition. There are wide variations in Salinity which affect the density of the ocean. Temperature changes are differing densities affect the circulation below the surface. So evident is this circulation that we say there are "rivers in the ocean." Florida's Gulf Stream is one of these "rivers" affecting, in turn, the land.

The Bell Telephone film, The Restless Sea, can be used to introduce the topic. Request for this free film should be made at least three weeks prior to time needed to insure its use. The film is in two parts requiring 50 minutes to view the entire film.

TEACHER DIRECTION E - 27

## THE WATERS FROM THE LAND INVADE THE OCEAN

The rivers and streams contribute land materials to the oceans. Theoretically land existed first without oceans, then the precipitation and runoff filled the vast area now called oceans. Plants and animals contribute to the chemical composition of the sea water. as well as change it. Wind picks up small particles hurled into the air by wave motion removing some of the suspended materials. The ocean's composition varies, but a general analysis is reported as:

96½ percent water ($H_2O$)

3 percent salt ($NaCl$)

½ percent other dissolved materials

Obviously this does not in any way compare to the land composition. The high salt ($NaCl$) composition of the ocean can be accounted for by the high solubility of salt, limited use by plants and animals living in the ocean, and water evaporation leaving the salt in the water.

Use transparency E-27 of the U.S. drainage system to introduce the idea of waters transporting land materials to the ocean. WHERE DOES THE WATER ON THE LAND COME FROM? Discussion. Rain. WHERE DOES IT GO? Streams to rivers to oceans. Discussion. A short review of infiltration, runoff, rivers, lakes, and evaporation using the transparency will reinforce a mental model. WHAT DOES THE MUDDY WATER CONTRIBUTE TO THE OCEANS? Discussion. WOULD YOU EXPECT THE OCEANS TO BE THE SAME AS FRESH WATER IN THE RIVERS? No. WHAT ARE SOME DIFFERENCES? Size, temperature, plants. animals, chemical, composition, etc. Discussion.

Teacher Direction
Page 2

LETS READ WHAT IS REPORTED BY SCIENTISTS. Lead them to appreciate the unanswer

questions about the ocean and that it is truly a frontier to explore.

Pass out E-27

After the students have read the activity, discuss the activity and answer the

questions.

STUDENT E - 27

THE WATER FROM THE LAND INVADE THE OCEANS

Sea water is different from the waters of the land. Why can't man drink it? Why can't he use seawater to irrigate his farm? The Earth material dissolved in seawater make it different from fresh water. What are these materials? Where did they come from? The flowing rivers and streams carrying tons of tiny particles of soil and rocks along with dissolved chemicals picked up in route to the oceans. The Mississippi River system alone dumps over a half billion tons of sediment each year into the Gulf of Mexico which leads into the Atlantic Ocean. Other rivers and streams race to the oceans to unload their muddy waters into the biggest "dumping ground" the ocean.

The salty water of the ocean receives the muddy waters from the land. The current immediately begins mixing, carrying, and depositing some of the sediment in the ocean. This introduces the newly arrived river material to its new home, the vast ocean. What happens to the water? Lets talk about a single little drop of water. If the little drop is typical it will spend on the average $98\frac{1}{4}$ out of every 100 years in the ocean. One year and eight months would be spent as ice on land, about fifteen days on the continent as fresh water in a lake or river, and less than a week in the atmosphere.

Seawater is a "soup" of every conceivable chemical. If the chemicals dissolved in the oceans could be taken out of the oceans and spread out evenly over all of the land, Jacksonville Beach and all other parts of the continents would be 540 feet below the surface. The most abundant chemical in the ocean is table salt which man has been taking from the oceans for years. Salt is not the only chemical man gets from the sea. Do you know of others? Fish in abundance, plants, pleasure, and employment for millions come from the sea.

Student
Page 2

What is this ocean like? No one knows all the answers, but we know some of them. We know it absorbs a lot of heat energy from the sun to help keep our climate pleasing and liveable. We know it has a wide variation of conditions. We know it has a wide variation of temperature. We know it has many currents flowing in different directions. We know most of the water that falls on the land comes from winds carrying water that was evaporated from the oceans. This list could go on, but we could also make a list of things we don't know about the oceans such as how many different kinds of animals live inthe ocean. What controls the currents in the oceans? Why are hurricanes always formed close to the equator? Will man ever live in the ocean?

We don't know everything about the ocean. We are learning more daily and in the future we will obtain more benefits from the sea.

Waves are even more fasinating. The winds blow across the ocean pushing the water into waves. The water in turn gives up heat to warm the winds. The waves action of the water increases evaporation and the winds become saturated with water, then in the form of rain, water is returned to the ocean.

What will temperature differences do? Will it cause the cold water to sink or rise? Will a current flow from the north pole toward the equator? If so, will the current from the North Pole flow along the bottom of the ocean or the top? Will warm water or cold water hold more salt? Will this affect the circulation of the water? Will it affect animals and plants? How?

TEACHER DIRECTION E - 28

## TEMPERATURE DIFFERENCE CAUSES SUBSURFACE CURRENTS

Materials for groups of three:

1. Clear plastic pan
2. Ice
3. Food dye (red)
4. Paper cup
5. Pop sicle
6. Beaker (250 ml)

This activity will show how cold liquids move downward and along the bottom of an area. The pop sicle shows this very well. The ice water will not be as reflective of the principle but is more realistic .

The reading activity E-27 should provide the understanding needed for students interpretation of this activity. A few brief introductory statements before students begin working is all that will be needed.

Using transparency E-28 of the activity, read the student direction with the students.

Upon completion of the activity reassemble for a class discussion. Discuss the questions at the end of the activity.

STUDENT E - 28

## TEMPERATURE DIFFERENCES CAUSE SUBSURFACE CURRENTS

Materials for groups of three:

1. Clear plastic pan
2. Ice
3. Beaker (250 ml)
4. Paper cup
5. Pop sicle
6. Food dye (red)

What happens in the oceans when the glaciers melt? What are the characteristics of water from a glacier? What will happen to the water from the glacier when it meets the ocean? Let's set up a demonstration and see what happens.

INVESTIGATION NUMBER 1

Fill a pan full of water and place the end of a pop sicle in the water at one end.

COMPLETE THE DRAWING SHOWING WHAT HAPPENS

Student
Page 2

INVESTIGATION NUMBER 2

Empty the pan of water used in activity one, then refill it with clean water.

Punch three holes in a paper cup with a pencil or ball point pen.

Add ice,.water, salt, and dye to a beaker and stir.

Place the cup with holes in it in one corner of the pan. Pour the red ice water into the cup and observe the results.

COMPLETE THE DRAWING SHOWING WHAT HAPPENS

1. Does the cold water seem to be heavier than the warmer water? How can you tell?

2. If wind cools the ocean surface, what will the cooled surface water do? Why do you think this happens?

3. Does the cold water from the pop sicle and cup cause a subsurface current below the surface? How can you tell?

4. If a river flowing into the ocean is warmer than the ocean's water, will the river water sink or stay near the surface of the ocean? Why?